The Foundry Trade Journal

AND

PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 9. AUGUST, 1907. No. 68.

—PUBLISHED—
THE FIRST WEEK IN EACH MONTH BY

EAGLAND & Co., Ltd.,
165, STRAND, LONDON, W.C.

Devoted to the interests and advancement of the Iron, Steel and Brass Foundry Trades.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "Journal" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5/- per annum, such order to be countersigned by the superintendent or foreman of the shop as a guarantee of good faith.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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BRITISH FOUNDRYMEN'S ASSOCIATION.

THE annual Convention of the Association will be held in Sheffield on Tuesday, Wednesday, and Thursday, August 6, 7, and 8, 1907. A good muster of members is expected.

BABBITTING OR LINING UP.

BY J. CLEMENTS.

IT has been said that if Izaac Babbitt could only see some of the metals that are reckoned "Babbitt Metal," though very often called by various names—fancy trade and otherwise—he would probably at once disclaim any connection with many of them; but, on the other hand, in some instances the addition or modifications of his "alloy" of white metal have been very consistently thought out, and, as a consequence, meet the requirements that probably did not exist in his time. Thus great changes are constantly taking place. Formerly, a few brasses were lined as we called it, or rather term it in shop practice, but now whole sections of engines, such as bedplates, etc., are Babbitted.

Much preparation has to be made for these, and if of a repetition character, jigs for the various parts are made very carefully and put in use. To define, or say jigs should always be used, would be misleading, as this can only be decided according to the number of linings wanted, or if it is regular or standard work.

In the illustration No. 1 will be seen a group of brasses; these have specially dovetailed pieces cast in them for holding fast the lining, and they were lined with an exceptionally good quality of Babbitt, much resembling the original specification. These were lined up in what might be termed a crude way, but there was reason for it.

The castings were first made in the ordinary way, being cored out, but with cores that left several recesses, then simply fettled; next cores were again made but less in diameter than the brasses would require to be when bored out; to allow for this, the brasses were next placed on the plated floors of the foundry, cores laid in and as near the centre as possible, and run up with the white metal or Babbitt. Now in this case I had upwards of 1,000 brasses to line up, and afterwards when the cores were cleaned out they were sent right away to be finished and bored out to size, and the ends radiussed at the same operation. This was a case in point of not wanting a mandril; the Babbitt metal in this case was also specially specified, belonging as it did to a very large Government order, and was a metal of great strength and hardness of the following composition :—

	Parts.
Copper	4
Tin	87
Antimony	9
Total	100

Turning again to the same illustration will be seen a compensating or gear wheel and also carriages; both of these classes of casting are largely used by makers of agricultural and traction engines. Let us take for our first example the lining of the carriages. In this case there is practically only half of the inside lined, and they are lined with the aid of a mandril or shaft of a given diameter.

First, the carriages are set in an upright position on a level plate, the mandril or shaft being placed in position and should fit into the recess marked with a cross, the metal filling in the vacancy on the opposite side. When lined, the carriages are placed on blocks of wood in such a manner that the mandril can be driven through with a sledge hammer, by main force, or by hydraulic pressure, but the latter need not be resorted to in ordinary cases. Sometimes large centres for traction wheels are similarly lined, but if, as I have found, on being a long distance through—18 or 20 in. say—it will be necessary to employ hydraulic pressure or have taper mandrils. Certainly, as an alternative, collapsable mandrils could be used if thought worth while, but when I say that to get a mandril out of a centre of such a casting of about 4 in. diameter and 18 in. long, a pressure of from 26 to 30 tons to the square inch has to be given, something can be gathered of the difficulty to be experienced unless some slight taper can be allowed in using such mandrils. In the same illustration will be seen one of the compensating wheels, but if the reader will turn to the illustration marked No. 2 a much better idea can be obtained, this being a case in point in which a fair amount of equipment in the shape of spindles and jig or mandril is required.

First, there is the main portion of jig;

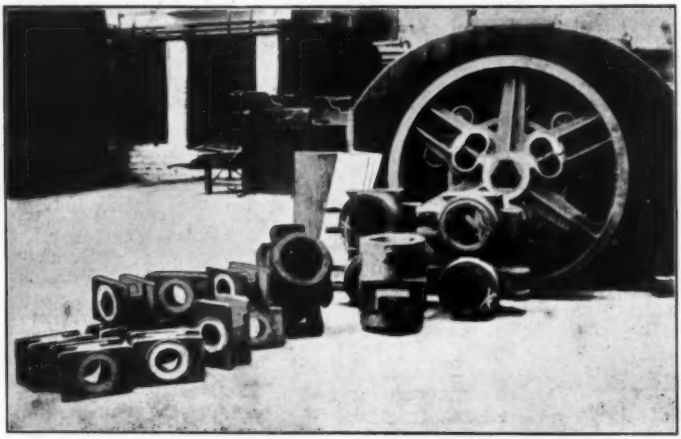

FIG. 1.

this is placed on the floor and the casting of wheel put on same, and, as will be seen, this jig comes through the centre of wheel. The small wheels, six in number, seen also in illustration, are attached to this jig; then there are three loose brackets fitting same, and the wheel when lined has six bushes.

When the casting of wheel is put in place on jig or mandril, then the spindles, seen also, are put in place, one end of each going right through casting to centre of jig. Next, to support these, the brackets mentioned are slipped in, these in turn supporting the outside ends of spindles; then the brackets, being in position, are made fast by the small wheels being worked down. Thus the spindles being in place and securely held, the little fitting, also seen in the illustration, resembling a bracelet and hinged, is at once slipped round one of the spindles and fastened. This so-called bracelet has an aperture to form the gate for the metal in pouring left at each end of it; the metal can then be cast to form these bushes, the small fitting being changed to each spindle in succession, being unhinged and the nut unloosed for the purpose, thus forming six bushes in perfect alignment. The spindles are afterwards forced out from the centre of jig by a ratchet arrangement to the side of casting, and out.

The small pinions for these wheels that fit in the recesses, shown with the spindles still in, are simply lined up in hole in centre roughly, like the first lot of brasses described, and bored out true to fit afterwards.

Coming to the arrangement of lining up the engine-bed illustrated in No. 3, this is a case of up-to-date lining, also with a jig and mandrils made and got out very carefully. Only large or repeat orders would warrant the expense of such an adjunct.

The bed is seen just as it had been lined, the jig for same is cast with brackets to support the shaft that runs from side to side. To produce the main

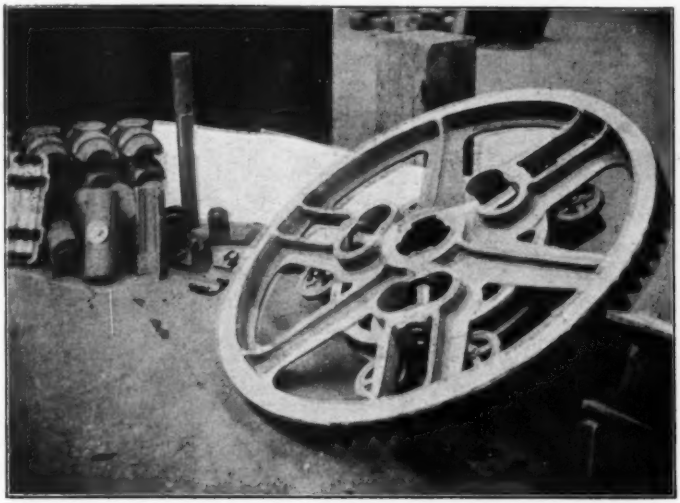

FIG 2.

shaft linings, the caps of these are loose castings simply bolted down, and in running these the caps are first taken off, then four pieces of asbestos millboard will be required one-eighth of an inch thick, cut to size, to place between the top and the bottom lining, otherwise a bush would be run and it would be impossible to separate them. When the bedplate is in position, by being drawn to the back of jig, where a lug fits into the back of large flange and is then fastened by bolts, then the shaft for the main shaft linings can be put in place, the caps put on and fastened down, and the two rings or collars that fit the shaft drawn up to one side of each of these linings and fastened

with a set pin, the other end being left open of each, to pour in the metal, and instead of pouring these bearings in a horizontal position the jig and bedplate are raised vertically and poured, being raised by a travelling overhead crab, thus ensuring a much better job.

Then there are two bushes, shown in illustrations, at the other ends of bed; into these are put shafts for a similar purpose, the one running from and through the end bracket, the other crossing from side to side in the brackets on the jig, and these, when in place, are for running the two bushes, and must have collars made to fit the shafts the same as the main shaft, with set screws to fasten them, but at the end of one of each of them an opening must be left as a gate true to fit the shaft, also seen in the illustration, that is used in the lining of them.

In the top shell will be seen three sections of white metal and four recesses. Two of the recesses are left entirely for the rings that revolve upon the shaft in use for oiling purposes, they being self-oiling, but in the case of lining up the shells, these, and the two end recesses shown, are first filled with sand, and then put in the stove and dried, afterwards being taken and simply set down upon a plate or bench, the shaft placed in shell and the metal poured into the intervening spaces, the sand from the recesses being afterwards knocked out.

The smaller shell shown in the illustration beside the others, is lined from end

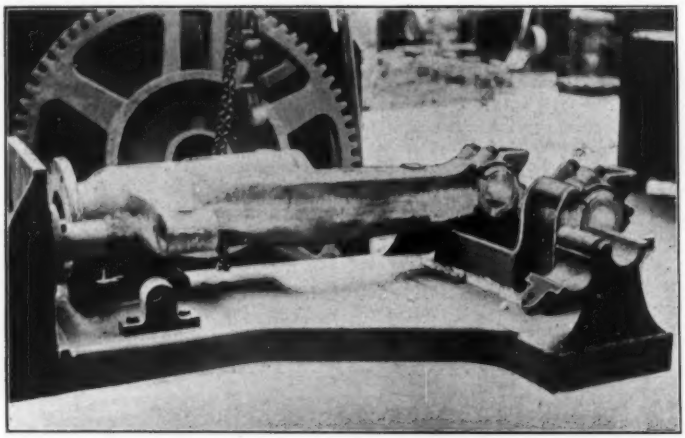

FIG. 3.

for pouring. These bushes, as also the main shaft linings, cannot fail, being in perfect alignment if carried out properly.

Much of the woodworking machinery sent here from America has to be, and is, done in a similar manner, and ensures a cheap method of lining machine parts, though, as is often the case, when these linings want renewing it proves a difficult task to people unacquainted with Babbitting, made more difficult by having to resort to makeshifts.

Turning again to illustration No. 2, will be seen on the left hand side a number of iron shells; these are for swivel and ring oiler carriages, and are Babbitted or lined. The two that are showing the channel side have already been lined up; these are first numbered and bored to end, excepting a slight rebate at each end, and as these shells are not tinned first, sometimes as an extra precaution holes are drilled partially through the shells to make the linings doubly secure, as the holding of same is purely mechanical. With the contraction of the metal that must take place upon solidification, precautions such as these are very necessary.

The bearings or brasses I shall next speak of and illustrate are generally called quarter-brasses (see illustration No. 4) in engineering practice, because each brass is only one-fourth of a complete set, unlike the generality of the castings which are in two halves. Each brass after being machined is numbered to its fellow one, and is then ready for

lining. How they fit together can be seen at a glance. In lining these up each one has to be treated separately; the mandril or shaft is stuck up, and each part is placed against it, the sides looked after, thin strips of wood being placed between shell and mandril, that reach from top to bottom of shell or brass, these to be the thickness of lining required. Sand is then rammed round, and when this is done one or two box or mould parts that are generally at hand in any foundry are used to ram them up in; the pieces of wood are then withdrawn. Iron can be used for the same purpose, and with the same object in the latter case, given diameters of iron will leave the required thickness; the linings are next poured.

The illustration shows two sets of these brasses before lining, and the rebates that hold the lining will be seen. In casting these, cores are used to leave these rebates in the casting, so that when they are lined the Babbitt cannot be removed without melting it out.

The sets of these brasses are afterwards assembled according to their numbers and bored out in the lathe.

The foregoing is a summary of many brasses and linings that are Babbitted, but in the case of many other "brasses" and bearings, they are first cleaned up and tinned, this being the strictly proper and approved way of Babbitting.

The brasses being cast, and cleaned sufficiently on the channel side for tinning, are then heated over a small stove or Bunsen burner, spirits of salts or borax being used as a flux, a stick of tin or a stick of the same kind of metal being used in the tinning as for the Babbitting.

When the brass is well covered, the surplus deposited can be wiped off with a little bunch of tow, cotton wool or waste, then if a complete mandril is being used for the lining up, the brass should be placed at once on mandril whilst hot and dripping with the tin or metal; then the metal should be poured. This is the true way of Babbitting, and effects a combination of the brass and lining that cannot be separated if properly done, unless melted out; and, further, the brasses treated thus, with the aid of a properly constructed mandril, should require no more finishing to be put into use at once, or of coring any apertures for holding linings.

One other aspect of Babbitting and lining only shall I endeavour this time to touch upon, and that is the linings of white metal that are cast independently.

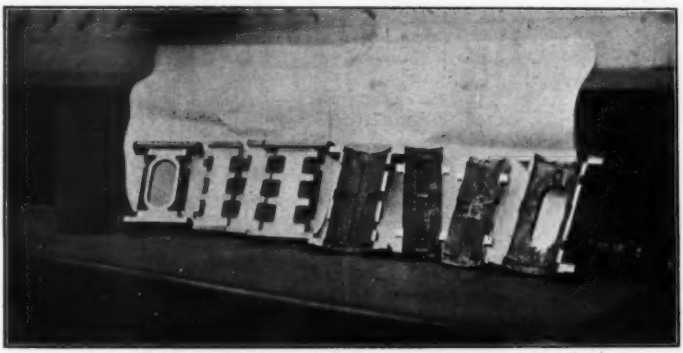

FIG. 4.

They are generally cast in sand from strips or patterns, these being the full length of the brasses they are intended for, and of the same radius, the edges being of rebate or dovetail form, the brasses or shells are cast with recesses to receive these, which are driven in with the aid of lead-hammers, etc. When the number required are in, they are then transferred to the lathe and bored out to the required diameter. In this case a stiff metal is required and should really be a white brass. The following would suit:—

	Parts.
Copper	5
Tin	26
Zinc	69
Total	100

Many more mixtures might be given, including many that contain a given per-

centage of iron, but approximately the mixture of many of the cheaper Babbitts are as follows :—

	Parts.
Lead	78
Antimony	16
Tin	6
Total	100

Some makers believe in one thing for addition and some another, but price, while sometimes of minor importance, is often a large factor with many firms who buy their white and Babbitt metals. Personally, I believe in an addition of iron and copper to "white brass" and copper to Babbitts or white metals generally, especially for linings of a heavy character, to prevent the metal spreading or being swaged under heavy loads. But for quick running and light machinery, the contents of antimony will be quite sufficient in most cases.

Many other classes of work, such as motor work, might be included, but for the present I will conclude my talk on Babbitting with this proviso :—Never overheat the metal, as owing to the volatile nature of antimony, the mixture of metal will soon be changed and unfit for use; in fact, if the metal is burnt, it will crumble in use. Never heat in a crucible what can be done in a boiler.

——o——

FIRE broke out in the roof of the engine-house at Messrs. Laidlaw's foundry, Glasgow, during the month, doing damage estimated at £150.

THE PRIDMORE ROCK-OVER DROP MOULDING MACHINE.

THE first Pridmore moulding machine to be designed was of the stripping plate type, admittedly a rapid machine, but its use is limited in a measure to the moulding of patterns from which there are a number of castings required. There are many foundries in which stripping plate machines cannot be used to advantage on account of there not being a sufficient duplication of castings to warrant the fitting up of the necessary patterns and stripping plates. It is for use in such shops as these that Mr. Pridmore has designed his Rock-over Drop machine.

In order that the description of this Rock-over Drop machine may be more readily understood, reference should be made to the accompanying illustrations which show the machine fitted with a ring pattern. The different views in the order in which they are given (Figs. 2 to 5), show the positions the machine assumes while in course of operation.

As its name implies, the two main operations of this machine consist of rocking the pattern over and dropping the mould away from the pattern. It can readily be seen that the nature of the rocking-over movement is such that facility is practically the only essential feature, but the dropping of the mould away from the pattern is the operation which must be accomplished with the greatest degree of accuracy; the movement of the adjustable table must be absolutely true.

By referring to the detailed view of the

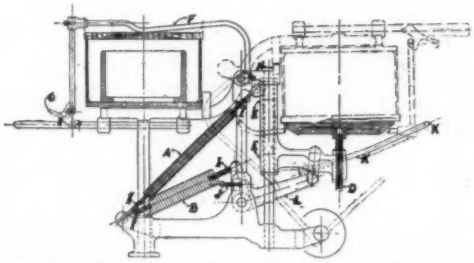

FIG. 1.—DETAILS OF PRIDMORE ROCK-OVER DROP MOULDING MACHINE.

A—Frame balance springs.
B Flask balance springs.
C—Self-adjusting flask rests.
D—Screws for regulating height of table to flasks of different depths.
E—Draw arms.
F—Adjustable clamping rod.
G—Clamping rod hook.
H—Frame stops.
I—Spring adjusting bolts.
J—Limit screws.
K—Foot lever.
L—Supporting arms.

machine (Fig. 1), it will be seen that the adjustable table consists of two movable draw arms (E), which travel vertically on two parallel steel uprights, and two self-adjusting flask rests (C) which are automatically adjustable to crooked bottom boards and to the variation in thickness of bottom boards and depth of flasks. These flask rests are connected with the draw arms by means of screws (D) which regulate the height of the table according to the depth of flasks to be used. Limit screws (J) are used for limiting the upward movement of the adjustable table. The weight of the flask and rod is accomplished by the use of a clamping rod hook (G). Frame spring balances (A) are used to facilitate the operation of rocking over, and the limit of motion is determined by the coming in contact of frame stops (H). The tension of both sets of springs can be readily regulated by firmly grasping them with both hands and twisting them forward or backward as may be required, spring adjusting bolts (I) being employed to take up or release the tension. The dropping of the mould away from the pattern is accomplished by the use of a foot lever (K), and the flask balance springs should be so adjusted that

FIG. 2.—FLASK RAMMED UP AND CLAMPED TO ROCK-OVER FRAME; PRIDMORE MOULDING MACHINE.

mould is perfectly counter-balanced and centrally supported by supporting arms (L) acting in conjunction with flask balance springs (B), which are capable of rapid adjustment to the weight to be supported. The clamping rod (F), which can be adjusted to flasks of different widths and depths, is so designed and fitted that the clamping of the bottom board and flask to the rock-over frame is performed at one operation, and in such a manner that it is absolutely impossible for either board or flask to shift while the mould is being rocked over. The instantaneous fastening and releasing of this adjustable clamping their tension will be sufficient to carry the table upward to its highest position after the pattern has been rocked back, thus obviating the necessity of the operator's stooping down for the flask to set it off on to the floor.

The operation of fitting patterns to this machine is an exceedingly simple one, and it can be performed very rapidly. Either wooden or metal patterns may be used. They should be firmly fastened to the pattern plate, which can be made of either wood or iron. Its upper surface should conform to the parting outline of the pattern which, in the majority of cases, will

be straight. This pattern plate, which should be made with ears, and fitted to accommodate the flasks to be used, is attached to the rock-over frame by means of bolts, which pass through four holes that are drilled in the frame.

This manner of attaching the pattern plate to the rock-over frame possesses advantages over spring latches or other inaccurate methods, as the frame is accurately milled on its upper surface, and if the pattern plate is at all uneven, as will frequently be the case, it will be sprung perfectly straight, the bolt holes being located one at each of the four corners of the rock-over frame. The cope part of the pattern, if it is perfectly flat

FIG. 3.—FLASK ROCKED OVER; PRIDMORE MOULDING MACHINE.

or has sufficient draft to permit of "lifting off," can be made on a stand or dummy such as is illustrated in Fig. 6. But if the mould cannot be lifted off without breaking, a regular stripping plate machine should be used.

These machines are now being placed on the market by Messrs. J. W. Jackman & Company, Limited, of Caxton House, Westminster.

——o——

STEEL, PEACH & TOZER, LIMITED, Phœnix Steel Works, Rotherham, have removed their London offices to 15, Victoria Street, S.W.

PRINCIPLES AND PRACTICE OF FOUNDRY WORK.*

BY MR. ROBERT BUCHANAN.

THERE are two main ideas usually held regarding foundry work, and they are these. One idea is that it is so simple, and especially grimy, as not to be worth serious study. The other idea is that foundry operations are so complex, and so subject to causations unexplained and unexplainable, as to make the study of foundry work too hopeless a task if one seeks for definite conclusions and definite results.

Between these two extremes there lies a middle field of ascertained fact helpful to the foundryman, and beyond the field of fact is a region of probability.

Most practical foundrymen are firmly of opinion that nothing of value regarding the business can be learnt outside of the foundry. One cannot, of course, learn foundry work by reading books, any more than one can learn to play the violin by the same method.

I am glad to bear testimony to the fact that in Great Britain we have the happiness to possess in our foundries workmen

* Abstract of Paper read before the Cleveland Institute of Engineers. A brief report of Mr. Buchanan's paper and the discussion thereon appeared in our April issue.

unsurpassed anywhere in the world. I regret that as regards the managers and foremen the same cannot be said. Here and there there are exceptions, of course; but, on the whole, in their particular positions they are not so able as the workmen are in their line of work.

To this it may be objected that, as most foremen at least are drawn from the ablest workmen in the foundry, the objection cannot apply. Quite so, but from the managers and foremen are required practical skill, plus something else. That something else is technical knowledge, and technical knowledge is simply getting to know all that can be learned regarding the laws governing the actions, changes, and conditions of the materials with which he works.

There is this to be said however; a practical foundryman with no technical training is to be preferred to one having a technical training but no practical knowledge. The practical foundryman with technical knowledge is infinitely superior to either, and there is an urgent demand for men thus equipped, a demand that is not being fully satisfied.

The problems daily confronting the foundryman are of no ordinary or simple character. With sand, and clay, and straw, symbols of instability through all the ages, he forms moulds which, while allowing copious gases to pass freely, hold molten metal within well-defined boundaries.

Moulding Sand.

All the materials used in connection with the making of moulds into which metal is run for the making of castings, possess certain qualities, one or more of which is made use of by the moulder. The part of the mould or core which comes in direct contact with the molten metal is invariably formed from a mixture of which silica or sand forms the greater part. The only exception is when iron moulds, either as a whole, or in part, are used to form "chill" castings; that is, castings having a hardened surface due to the quick cooling of the iron run into the chill mould. Silica, or sand, is infusible at the highest temperature obtainable in ordinary workshop practice. Hence its use in foundries as the material used for direct contact with metals. Silica by itself, however, wants one quality which must be present before moulds or cores can be made. That quality is cohesion or "bond," and is wholly absent when the sand is pure silica, as in the case of "silver" sand. The substance present in moulding sand, then, is something which not only binds the particles of sand one to another, but at the same time keeps them in the certain

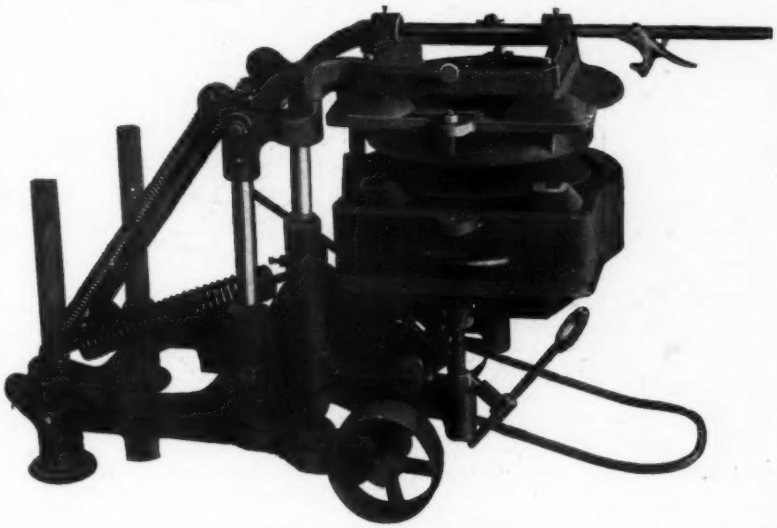

FIG. 4.—CLAMPING ROD RELEASED AND MOULD DROPPED AWAY FROM PATTERN; PRIDMORE MOULDING MACHINE.

definite position into which they are put by the workman.

Clay, or Silicate of Alumina.

The material which forms the cohesive substance or bond in moulding sand is clay, or as the chemist calls it silicate of alumina, because it is a compound of which silica and alumina are the component parts.

The proportion of clay usually found in moulding sand ranges betwixt 4 and 14 per cent., the higher amount being unsuitable for moulds which are not dried.

FIG. 5.—PATTERN ROCKED BACK AND FLASK RAISED READY TO BE SET OFF; PRIDMORE MOULDING MACHINE.

The admixture of sand and clay may have the latter in such excess as to lower the fusing point sufficiently to cause cores made from such sand to frit, or partially fuse, when surrounded by the molten iron. This is not a common occurrence, but when it does occur it causes very considerable trouble to get the cores out of the casting, these being almost as impenetrable as the metal itself. At this point it may be observed that the fusing or melting point of any mixture of two or more elements or oxides of elements, whether metals or non-metals, is almost invariably lower than the mean of the individual melting points of the elements forming the mixture. Silica or alumina is each of them infusible, but a mixture of the two is readily fused. Lime is also infusible, but a mixture of silica, alumina, and lime is very readily fused.

The fusing of core sand is, however, not common, and probably takes place only when appreciable percentages of lime are present. Before this can happen simply from excess of clay, a certain condition has probably arisen which renders a core or mould useless for the purpose intended. The condition is that of impenetrability to gases. No matter what qualities materials for core-making or moulding purposes may possess, they must possess one special quality, namely, that of being readily penetrated by the gases generated by the molten metal when poured into the mould.

The amount of cohesive matter or bonding material is thus limited to such an amount as is not sufficient to destroy the porousness of the sand, so that gases readily pass through it when rammed firm enough to resist the penetrative power of metal.

It is to be observed that when a nice smooth surface is formed on a casting, it is derived from solid carbon or from the gaseous hydro-carbons, or from both of these. Mineral blacking (usually made from the carbon deposits found in gas work retorts), plumbago, and charcoal are examples of solid carbons used. Coal-dust mixed with the sand is the usual source from which hydro-carbons are obtained.

When the mixture of moulding sand has a high fusing point the mould need not be coated with solid carbon, but may depend upon the hydro-carbons from the coal-dust to form a nice skin. When the sand is readily fused, a thin layer of solid carbon has to be interposed betwixt the molten metal and the sand. The reason for using carbon is, it is absolutely infusible.

FIG. 6.—STAND OR DUMMY FOR MOULDING COPE; PRIDMORE MOULDING MACHINE.

MOULDING SANDS (Buchanan, "Engineering Magazine," February, 1903.)

	Mansfield. Per cent.	Erith. Per cent.	S. Staffordshire. Per cent.
Silica	94.02	87.85	93 40
Alumina	3.73	5.04	4.06
Oxide of iron ...	2.07	4.23	2.14
Lime...	—	0 30	—
Loss on ignition...	—	2.41	—
	99.82	99.89	99.60
Clayey matter removable by washing... ...	4.70	—	4.90

COAL DUST FOR MOULDS (sample dried at 100 deg. C.)

	Per cent.
Sulphur	0.973
Ash	10.470
Hydro-carbons	33.760
Fixed carbon	54.797
	100.000
Moisture as received	6.05

Cupola Practice.

It is not my purpose to bring before you the characteristics of various types of cupolas.

The volume of air is important. It may be objected to low pressures that with a cupola of large diameter the air will have difficulty in reaching the centre of the cupola. It must, however, be remembered that there cannot be an area of lower pressure in the centre than obtains nearer the circumference. Were there an area of low pressure at the centre the air and gases at a higher pressure would instantly go there, and the pressure be immediately equalised. There is the additional fact that the tuyeres are all blowing towards the centre, and baffling each other there. If one has a cupola of 25 in. or 26 in. diameter having only two tuyeres and one is turned off, melting is greatest on the side having the tuyere turned off; the air is most effective on the side furthest from its entrance. This disposes of the supposition that there is an area of low pressure at the centre of large cupolas. In the table given on next page, taken from Mr. C. Morehead's paper, "Notes on Cupolas and Cast Iron," read before the Rugby Engineering Society, he shows a steady decline in quantity of iron melted per foot of superficial area with each increase of diameter of cupola. I have no doubt whatever that the parts of the cupola which are not contributing their due share of the melting are those areas near the circumference and lying between the tuyeres.

Mr. C. Morehead's Tables of Cupola Melting.

TABLE I.

Showing approximate results to be obtained from ordinary cupolas under favourable working conditions: —

Diameter of furnace.	Area in superficial feet.	Amount in tons melted per foot of furnace area.	Tons melted per hour.	Blast pressure in ounces.	Ratio coke to iron.
In.		Tons.			
20	2.2	0.80	1.65	6	1 to 7
36	7.07	0.75	5.3	10	1 „ 7
46	11.54	0.70	8.078	14	1 „ 7
50	13.63	0.65	8.86	16	1 „ 7
60	19.63	0.60	11.77	16 to 18	1 „ 7

TABLE II.

Table showing approximate height of melting zone and coke bed. They are practically the same for all diameters of cupolas: —

	In.
Height of bed charge of coke above tuyeres	18
Height of bed when ready for first charge of iron...	10
Height of bed top of melting zone above tuyeres...	36

We now proceed to consider how economies have been effected in cost of melting. These can be dealt with very shortly. The heightening of cupolas is probably the most important means to that end. The gases generated in the melting zone have to part with the greater part of their heat in passing through the iron and other materials which fill the cupola, and thus the materials get heated ready for the melting to be accomplished in the melting zone. The high column of materials has also the important effect of reducing the velocity of the ascending gases, and so combustion is more thorough.

Some foundrymen reduce the diameter of the cupola in the region of the tuyeres, but this is not an universal custom. This drawing-in saves a certain amount of coke when forming the bed. This drawing-in of diameter has, however, as its principal advantage the delivery of the blast where it becomes effective over all the area of the cupola, and areas of non-effective melting are eliminated.

To balance these advantages there is the undoubted fact that cupolas so drawn-in, more readily "hang up" or "scaffold," and there is the weekly building of brickwork, or ramming of ganister round a plug to do, and the cost of these materials to consider. Drawing-in the cupola at the tuyeres saves coke and distributes the blast well, but it is not the unmixed blessing it is often claimed to be.

It is well to remember that the bed of coke first put on the cupola has three functions only. The bed acts as a column to hold the first charge of iron in its proper position above the melting zone. Secondly, the top of the bed does the first melting. Thirdly, the bed in front of the tuyeres heats the blast, and uses part of it, the more perfect combustion taking place in the melting one. The melting zone of a 36-in. cupola, with two rows of tuyeres, and blast pressure of 8 ozs. begins at 6 in. to 8 in. above the upper tuyeres, extends vertically for 24 in. and terminates abruptly. Increase the blast pressure and the depth of the melting zone is increased, and *vice versâ*. It is to be noted that the region from the bottom of the bed to the top of the tuyres is comparatively cool; certainly not hot enough to melt iron, as was proved by Dr. Kirk. Cupola-men, almost without exception, waste the coke beds by kindling them too early before charging of iron begins. The first iron melted will always be hottest if blowing begins with the coke opposite the tuyeres simply at a red heat.

Melting takes place only in the melting zone, no other where, and the charges of coke placed betwixt the charges of iron are for the purpose of replacing the wastage of the bed. Coke added in excess of what is necessary for this purpose is wasted. Excess of coke also decreases rapidity of melting, contrary to what one might expect. The use of too much coke is not only wasteful, but, as all coke contains sulphur, it increases the amount of sulphur available for being taken up by the iron, and increases the quantity of slag unnecessarily.

Cupola Linings.

These are almost invariably of fire-bricks, and like the ganister with which repairs are made, are readily acted upon by oxide of iron. Silica, the principal constituent in fire-bricks and ganister, with oxide of iron, or rust, forms slag. Thus it is that burnt iron and rusty scrap waste cupola linings so excessively.

GANISTER.

	Sheffield. Per cent.	N. Wales. Per cent.
Silica	86.48	91.23
Alumina	4.57	4.09
Oxide of iron...	3.43	0.40
Lime	trace	0.17
Loss on calcination ...	5.46	2.18
	99.94	98.07
Moisture as received ...	0.90	0.45

Basic Lining for Cupolas.

Five or six years ago it was suggested to me that probably a basic lining of burnt dolomite and boiled tar, just such a lining as is used in the basic Bessemer converter for making steel, would make a cupola lining superior to the silicious linings in ordinary use. We ought to have known better, but we made the trial, and the details of the trial may not be without their lesson. The cupola was one of Thwaite's "Rapid" cupolas, 36 in. in diameter inside, and drawn in to 19 in. at the tuyeres. In front there is a receiver, which is connected to the cupola by a massive fire-brick 5 in. thick. The following is transcribed from my notes of the test:—

Rammed cupola with dolomite and tar. Bottom rammed to 19 in. diameter for 4 ft. 6 in. up, or 12 in. above the upper tuyeres. Then rammed up full diameter to within 2 ft. of the charging door. All above that was fire-brick. Melted 11 tons 4 cwts. in basic lined cupola. Metal hot, and latterly metal threatened to come through connector brick betwixt cupola and receiver. In morning found bottom of connector brick had been fluxed right through. The basic lining was practically unchanged, and had almost no slag adhering. Lining was cracked in various directions. The sand bottom of cupola had been fluxed almost wholly away. For the next test the bottom of cupola was made up with sand, and on top of the same was rammed 1½ in. of ground coke and boiled tar. The latter was to prevent the fluxing of the sand by the basic slag. The bottom of the connector brick was made up with chrome ore, with tar as a bond. Melted 10 tons. Metal hot, but melted slowly, as tuyeres were rather small. No slag at the tuyeres, and so required no pokering. Bottom of cupola held good, but the chrome ore and tar in bottom of connector brick had gone. As the ground coke and tar in bottom of cupola had held good, bricks of a similar material were made and laid along the connector brick, but the metal got under the bricks and threatened to leak through. After trying other expedients wet weather ensued, and rain evidently got in at the back of a portion of the lining. This resulted in a part of the lining being blown off, and we burnt a large hole in the shell 6 ft. above the melting zone. As we had had only six heats and a new lining was required, we came to the conclusion that basic linings in cupolas were a failure. A great difficulty was the keeping of the bottom doors tight, the basic slag having such an affinity for the sand with which they were made up. The object we had in view was to obtain a lining which, while proof against the heat, would at the same time not be readily attacked by oxide of iron. The basic lining was, however, fluxed away by the sand adhering to the scrap and pig-iron. Another objection was that already stated, it being so seriously affected by damp, an objection which does not apply to silicious linings except in a minor degree.

Coke.

To most foundrymen the silvery, lustrous appearance of "Bee-hive" oven coke appeals strongly, and no doubt some samples of it are simply beautiful, both in colour and structure.

By-product coke then is black and unsightly, but in no other respect is it inferior to "Bee-hive" oven coke, and I have used thousands of tons of each kind. The "black coke," as the cupola men call it, is of an irregular structure, and does not break down into small pieces so readily as the "Bee-hive" oven coke.

Coke should be of a density sufficient to cause it to sink in water. Ash should not exceed 8 per cent.

The following analyses may be taken as illustrative of what a first-class foundry coke should be:—

	North's Navigation. Per cent.	Altham. Per cent.	Habergham. Per cent.
Sulphur	0.603	0.712	0.262
Ash	6.400	6.010	5.310
Volatile matter...	1.630	—	—
Carbon (by difference)	90.547	92.370	94.428
	99.180	99.092	100.000

Pressure and Volume of Blast.

One meets amongst foundrymen most varied practice regarding the pressure of blast used. It is a fortunate circumstance that melting may be done with pressures varying from 4 ozs. to 30 ozs., these extremes being found in different works, of course. It is advisable to avoid either extreme, the best results being obtained with pressures from 12 ozs. to 16 ozs. These pressures are suitable for cupolas 36 in. to 54 in. diameter inside.

The volume of air required to melt 1 ton of iron is usually stated to be from 38,000 to 40,000 cubic feet. If one blows in more air than is necessary to completely oxidise the carbon in the coke, then the oxygen contained in this excess of air will oxidise some of the silicon, manganese, and carbon in the iron; not only so, but will oxidise the iron itself. Cutting the coke down to a fine point, and

increasing the pressure and volume of blast, provide the necessary conditions for such a result. If "loss of iron in melting" were not so difficult to ascertain, the results of over-blowing would be more obvious than they usually are.

One result following over-blowing is a lowering of the total carbon present in the iron, and this helps to produce excessive "liquid contraction." In fact, oxidation of the carbon in the iron precedes oxidation of the iron itself, but the combined effect of both oxidations is in some measure seen in the liquid contraction which takes place.

That pressure and volume of blast have a great influence on the hardness or softness of castings is undoubted.

A foundry making high-class engine castings found bewildering variations in the hardness of their cylinders. The same mixture of iron, melted by the same quantity and quality of coke, did not give the same hardness of casting twice in succession.

After looking in all directions where it was thought possible a solution could be found, and failing to find one, a friendly foundry manager suggested testing whether the blower was giving a regular blast. The blower, driven by an electric motor, was tested throughout a run of the cupola, and was found to vary considerably in speed during the heat. This was rectified, and when regular blowing was obtained the metal was of a regular hardness day by day. When the pressure and volume of blast were low the castings were soft, which is an objection in cylinders. Occasionally one may see in small castings examples of the effect of loss of carbon through over-blowing. These present the curious phenomena of being hard at the centre and soft outside, and have a well-defined boundary line betwixt the two qualities of iron. The absorption of carbon from the coal dust and blacking of the mould probably accounts for the zone of soft iron. Excess of oxygen in the cupola is to be avoided and complete combustion to carbon di-oxide not to be desired, seeing this gas is itself an oxidising agent. The only constituents of iron which one would desire to oxidise and get rid of are sulphur and phosphorus. Sulphur is very slightly affected by the blast, and phosphorus not at all. Silicon, manganese, carbon, and the iron itself are all readily oxidised, and these are the constituents of cast iron which we wish to remain unchanged. We are safe in assuming that rapid melting with a low consumption of coke may be purchased too dearly by depreciation of quality, loss of iron, and loss of the constituents which make the iron valuable to the foundryman.

Foundry Pig-Iron.

The classification of pig-iron by numbers, 1, 2, 3, etc., is, we may fairly suppose, based upon the assumption that the number conveys to the buyer an adequate idea of quality. To most foundrymen the value of, say, a No. 1 pig-iron, lies in the supposed fact that such a pig-iron will carry more scrap without hardening the castings, or, unmixed, run small castings without chilling.

As numbering of irons is based on the appearance of the fracture, and appearance of fracture is mostly governed by the length of time the pig-iron took to cool, this shows how inadequate and misleading is the judging of quality by appearance of the broken pig. Some blast furnacemen say the carbon is what gives a broken pig its distinctive appearance, others maintain that it is the sulphur. It may be granted that an open-grained fracture and a high percentage of sulphur are not readily found in the same iron. This is so for the reason that sulphur causes the retention of carbon in the combined form, and such a pig-iron cannot fail to be close grained. Phosphorus gives to pig-iron a whitish appearance, varying in intensity according to the percentage of phosphorus. Manganese also has an effect upon appearance of fracture, and in short each constituent has an effect. To these various effects due to the constituents, add that already mentioned, namely, the rate of cooling, and judging an iron by fracture with any approach to accuracy becomes an impossibility.

We would be indignant with a judge who decided a case from the appearance of the witnesses, but many foundrymen consider themselves quite competent to judge of pig-iron with not a whit more sensible procedure. If one acts upon the assumption that blast furnaces are not to be relied on to give regularly the same quality of iron, one is much more likely to be nearer the truth than by having a blind faith that blast furnaces do *not* go wrong, and that the ores and coke used never vary in composition and quality. The foundryman will readily admit that his castings vary. It would be a miracle if they did not, if he relies on the blast furnacemen for regularity of quality in his castings.

The blast furnaceman is not in business for his health, and he naturally passes on to the foundryman whatever will pass muster. The man who buys by fracture

has practically no protection, and his castings may be hard or soft, strong or brittle, and he usually does not know why either condition should prevail.

The following analyses show the variations in six consignments of iron of one brand and one number. This iron has consistently low sulphur:—

							Maximum variation.
							Per cent.
Silicon	3.337	3.359	2.239	2.799	2.293	2.706	Si. ... 1.120
Phosphorus ..	1.110	0.898	1.581	1.548	1.558	1.636	P. ... 0.738
Sulphur	0.016	0.041	0.045	0.032	0.037	0 051	S. ... 0.029
Manganese ...	0.410	0.362	0.274	0.280	0.308	0.337	Mn. ... 0.136
Combined carbon	0.581	0.496	0.245	0.026	0.152	0.066	C.C. ... 0.555
Graphitic carbon	3.442	2.462	3.501	2.708	3.250	2.880	Gra. C.... 1.039
Total carbon ...	4.023	2.958	3.746	2.734	3.402	2.946	Total C. 1.289

How is one to characterise the recommendation and supply of an iron like the following to be used in a mixture for castings, to be chilled on one face, machined freely on the other, and be subject to shock when under working conditions:—

	Per cent.
Silicon	1.351
Phosphorus	3.665
Sulphur	0.035
Manganese	1.056
Combined c rbon	0.674
Graphitic ,, ...	2.245

This is an iron suited only for making "basic" steel, and is worse than useless in a foundry.

It is an unfortunate fact that hematite irons—at once the most expensive and supposedly reliable irons—are the most guilty in respect of high sulphur. One of these on analysis proved to have 0.25 per cent., or six times the amount of sulphur it ought to have had. Enough has been said to show that foundrymen must learn the real, actual constitution of the irons with which they hope to produce castings of definite quality. The foundryman who knows his business as it ought to be, and can be, known, is able to produce work of regular quality day by day, with a minimum of variation. To do so, however, he must take his fate in his own hands, and not rely upon the skill or goodwill of outsiders, whether they be makers of iron or coke, or any other material the foundryman uses. These people are legitimately employed in running their own businesses, and the foundryman will find that it will pay him to know all there is to be known about the materials with which he works, and to depend on his own practical skill, reinforced by the skill of the scientist. He has got to realise that in foundry operations the forces he deals with, and the laws governing these forces are as fixed as the forces and laws governing the motion of the earth round the sun. We may be ignorant of these, and cloak our ignorance, and speak of variations we do not understand, calling them accidental.

Liquid and Solid Contraction.

"Liquid contraction" is a term used by Longmuir to distinguish the local contraction which takes place in the heavy part of a casting before it solidifies. This is also known as "sinking," "draw holes," etc., and "sponginess" is a variant of these. "Solid contraction" is the natural contraction which metals undergo when passing from the hot to the cold condition. Solid contraction is also known as "shrinkage."

In the remarks about to be made about liquid and solid contraction an endeavour is made to state some conditions which prevail, and must be taken account of in dealing with this most important and difficult subject. One cannot be long in the company of foundrymen without being impressed by the fact of how largely it bulks in their minds, and how little is known about it. There is little doubt that these two forms of contraction are closely related as regards occurrence and extent, that is, the conditions which conduce to a minimum solid contraction are also those which conduce to a minimum liquid contraction. On the other hand, the conditions which conduce to a maximum solid contraction are also those which produce a maximum liquid contraction. This indicates some connection betwixt the two phenomena. Cast steel has a greater contraction than a cast iron having low total carbon, and a cast iron with low total carbon has a greater contraction than one with high total carbon. Quantity of carbon has thus an influence in determining the amount of contraction. The condition of the carbon also has an effect upon both forms of contraction. A white iron contracts more than a grey iron, graphite being absent from the former. Carbon in combination with the iron, that is, in the form known as combined carbon, has practically no more influence in reducing

contraction than if it were absent altogether. The condition of the carbon is thus a determining influence on the amount of contraction, both liquid and solid.

If one took, say, 3 cwts. of ordinary grey iron and ran it into a pipe 9 ft. long, the solid contraction would be about one-eighth of an inch per foot of length. If this iron had been run into a square block, the solid contraction would be less than in the case of the pipe, but the liquid contraction would be evidenced by a "sinking" or drawing away of the iron which was last to solidify. The two contractions together, in the case of the block of iron, are not so great as the solid contraction alone in the case of the pipe, for the reason that the slow cooling of the block favours the more thorough separation of graphite. As we have seen, the more graphite there is, the less is the contraction.

If the lighter part of a casting can draw liquid iron from a contiguous heavy part it will do so, and thus lessen its own solid contraction. Each part in turn borrows from the more fluid iron next it, and the part which lends iron and cannot itself borrow exhibits what we term a "shrink hole," "sinking," or the better term, liquid contraction. Under the conditions mentioned, a heavy part lending liquid iron and not being in a position to borrow, it is the business of the skilful foundryman to supply the deficiency by "feeding." This is neither more nor less than replacing iron which the heavy part has been called upon to give up to lighter sections which, in the absence of such a supply, would have an increased solid contraction. Some foundries use irons with high total carbon, and with well proportioned castings "feeding" is exceptional. Freedom from liquid contraction is thus obtained by all parts of the casting setting at nearly the same time, and the solid contraction is normal owing to the quantity of carbon available for turning into graphite.

It is difficult to say at what stage of the cooling of the parts first to freeze this borrowing of liquid iron takes place. Keep showed that an iron having 3.85 per cent. of silicon and 1 per cent. of phosphorus had three expansions while passing from the fluid to the solid and thence to the cool condition. As already mentioned, Professor Turner shows that hematites have only two expansions, and thus the second expansion observed by Keep is due to the formation of the phosphorus eutectic, the particular compound of iron and phosphorus, having the lowest melting point. It is to be understood, of course, that there is no ultimate expansion of either iron.

Had hematites three expansions instead of only two, the other constituents being similar in amount, then the solid and liquid contractions would be the same as with a phosphurettic iron in a given section of casting.

No casting sets or freezes in all parts at once, and thus in every casting we have, at a given time, the fluid and solid conditions present.

Most foundrymen are agreed that a casting run with "dull" iron does not so readily "sink" or "draw," as metal which is run hot. That is, the liquid contraction is less with the iron which is lowest in temperature. The ability of molten iron to keep carbon dissolved within it is very largely a matter of temperature. The lower the temperature the less readily can the iron hold the carbon in solution. When iron is pretty fully saturated with carbon, a slight fall of temperature, accompanied by a jumbling of the metal such as takes place when carrying a ladle, suffice to liberate some of the carbon as "kish." So in pouring iron at a low temperature the act of pouring assists the liberation of the carbon as graphite in greater proportion than when cast hot.

The conclusion then is, that both liquid and solid contractions depend almost wholly upon the quantity of carbon which takes the graphitic form. This is absolutely so as regards grey hematites, and in the case of ordinary foundry irons is only to be qualified by taking account of the slight expansion due to the formation of the phosphorus eutectic.

The considerations stated and conclusions drawn may apply perfectly to grey irons, and yet not be wholly applicable to irons low in total carbon, silicon, and manganese. In such irons it is possible oxide of iron plays a part, but as yet there is no actual proof of this so far as the author knows.

Mr. F. J. Cook, Vice-President of the British Foundrymen's Association, has kindly given the author the results of some of his experiments made with mottled irons for casting cylinders, also experiments with hematites and phosphurettic irons for ordinary castings.

The solid contraction tests were made with Keep's apparatus, and the figures given indicate in decimals of 1 in. the contraction in 12 in. The hardness tests were made on a special drilling machine with a twist drill mechanically sharpened to a definite cutting angle.

It was observed that when using mottled irons for cylinder castings the bosses often showed "drawn" holes, that is, liquid

contraction; or they might be spongy, which is a variant of the same trouble. To discover which iron was causing the trouble a liquid contraction test was devised. This consisted of a pattern 6 in. long by 1 in. thick, made in the form of a letter K.

Each iron was melted by itself, in a small cupola, and all were melted under as exactly similar conditions as possible. When the irons which showed excessive liquid contraction in the "K" casting were left out of the mixture, excessive liquid contraction was also absent from the cylinders.

The author has appended some explanatory notes regarding these irons.

Notes on Mr. F. J. Cook's Experiments with Cylinder Irons.

"A" Iron.—This iron has the greatest solid contraction of the series as measured on Keep's apparatus, viz., 0.239 of an inch, bar being half an inch square and 12 in. long. Also has greatest liquid contraction, is fourth in order of softness, and has lowest graphite of the series. The latter fact probably accounts for the excessive liquid and solid contractions.

Warner Iron.—Has lowest solid contraction of any, and is third in order of softness. Total carbon is same as the "A" iron, but the higher silicon has increased the graphitic carbon slightly. This iron presents a very satisfactory combination of qualities

Grazebrook Iron.—Is second in order of greatest solid and liquid contractions. Is hardest of the series, and has the highest sulphur, viz., 0.136 per cent. The hardness is directly derived from sulphide of iron, the combined carbon being not excessive.

Madeley Wood Iron.—Has same graphitic and combined carbon as Warner iron, but has greater solid contraction. Has lower silicon and sulphur, higher phosphorus, and considerably higher manganese. Is softer than Warner, and shows that 1.296 per cent. of manganese has had no hardening effect. Gives a high tensile test of 16.55 tons per square inch.

Goldendale.—This is second in order of hardness, and this is probably due to the high phosphorus. Solid contraction is the second lowest, and combined carbon is lowest of the series. This is probably due in some degree to the complete neutralisation of the sulphur by the large percentage of manganese.

G.R.T. Special Iron.—Highest total and graphitic carbon of the series. Is also the softest, and has comparatively low transverse test. With such a low silicon as 0.7 per cent. and fairly high sulphur, one would expect considerable solid and liquid contraction, but this has been obviated by the amount of total carbon available, with the resulting increase of graphite carbon.

Table No. 1.—*Experiments with Cylinder Irons.*

Particulars.	"A" Iron.	Warner.	Graze-brook.	Madeley Wood.	Golden-dale.	G & R. T. Special.
Date of blow	14-3-06	16-3-06	20-3-06	22-3-06	17-5-06	8-6-06
Coke used for bed	280 lbs.	280 lbs.	280 lbs.	280 lbs.	280 lbs.	280 lbs.
Time blower started	11.20 a.m.	11.30 a.m.	11.10 a.m.	9.55 a.m.	11.15 a.m.	11.5 a.m.
Time metal appeared	11.30 a.m.	11.42 a.m.	11.20 a.m.	10.8 a.m.	11.27 a.m.	11.15 a.m.
Appearance of metal	Good hot	Good hot	Good hot	Good hot	Good hot	Good hot
Time blast shut off	12.5 p.m.	12.15 p.m.	11.40 a.m.	10.40 a.m.	11.50 a.m.	11.40 a.m.
Total iron melted	10-0-0	10 0-0	8-0-0	15-0-0	5-0-0	5-0-0
Total coke used	392 lbs.	392 lbs.	392 lbs.	448 lbs.	336 lbs.	336 lbs.
Average blast pressure	8 ozs.	8 ozs.	8 ozs.	8 ozs.	8 ozs.	8 ozs.
MECHANICAL TESTS.						
Solid contraction on ½ in. bar No. 1	.239	.164	.235.235	.213	.175	.209
" " " " " " 2	.239	.164	.235.235	.213	.175	.209
Transverse test on ½ in. bar No. 1	470 lbs.	565 lbs.	465 lbs.	520 lbs.	490 lbs.	370 lbs.
" " " " " 2	490 lbs.	590 lbs.	490 lbs.	Broken	Scrap	370 lbs.
Deflection test on ½ in. bar No. 1	⅝ in.	¼ in.	⅝ in.	⅛ in.	7/32 in.	⅛ in.
" " " " " 2	⅝ in.	¼ in.	¼ in.	Waster	Scrap	⅛ in.
Drill test on 1½ in. bar No. 1	84 revs.	79 revs.	103 revs.	75½ revs.	97½ revs.	62 revs.
" " " " 2	86 revs.	78 revs.	103 revs.	75¼ revs.	97½ revs.	63 revs.
Transverse test on 1 in. bar No. 1	2,856 lbs.	3,472 lbs.	Too hard	3,640 lbs.	3,108 lbs.	—
" " " " 2	2,716 lbs.	3,584 lbs.	Too hard	3,416 lbs.	2,688 lbs.	—
Tensile test per sq. in. No. 1	11.1 tons	Waster	Waster	16.46 tons	Waster	13.1 tons
" " " " 2	7.4 tons	Waster	Too hard	16.55 tons	Waster	13.08 tons
ANALYSIS.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	.851	.720	.634	.720	.500	.786
Graphite	2.149	2.280	2.506	2.280	2.500	2.759
Silicon	1.446	1.805	.783	1.260	1.820	.700
Phosphorus	.140	.352	.452	.769	1.708	.590
Sulphur	.062	.080	.136	.050	.052	.090
Manganese	.380	.720	.648	1.296	1.873	.720
Appearance of "K" test, for liquid contraction	Sunk and drawn badly. Very spongy.	Perfectly solid.	Sunk, drawn and slightly spongy.	Perfectly solid. No sponge.	Slightly drawn, but perfectly solid. No sponge.	Perfectly solid.

TABLE No. 2—*Experiments with Hematite Iron.*

	Blaenavon.	Harrington.	Blaenavon Sp.	Cleator.
MECHANICAL TESTS.				
Solid contraction on ½ in. bar No. 1	.15	.202	.142	.18
" " " " " 2	.15	.202	.141	.18
Transverse test on ½ in. bar No. 1	350 lbs.	295 lbs.	295 lbs.	291 lbs.
" " " " " 2	350 lbs.	300 lbs.	300 lbs.	291 lbs.
Deflection test on ½ in. bar No. 1	⅛ in.	⅛ in.	⅛ in.	¼ in.
" " " " " 2	⅛ in.	⅛ in.	⅛ in.	¼ in.
Drill test on 1½ in. bar No. 1	None cast	70 revs.	52 revs.	43 revs.
" " " " " 2	"	72 revs.	53 revs.	42 revs.
Transverse test on 1 in. bar No. 1	"	2,156 lbs.	1,960 lbs.	1,624 lbs.
" " " " " 2	"	2,156 lbs.	2,016 lbs.	1,624 lbs.
Tensile test per sq. in., No. 1	"	7.89 tons	Waster	6.88 tons
" " " " 2	"	7.18 tons	"	—
CHEMICAL ANALYSIS.	Per cent.	Per cent.	Per cent.	Per cent.
Combined carbon	.467	1.048	.545	.655
Graphite	3.242	2.442	3.491	2.563
Silicon	2.100	1.829	1.866	1.446
Phosphorus	.044	.044	.055	.040
Sulphur	.042	.062	.014	.020
Manganese	1.580	.144	1.368	.216
Result for "K" test for liquid contraction	Not cast	Slight draw and open in centre.	Very open grained.	Slight openness in centre.

TABLE No. 3.—*Experiments with No.* 3 *Iron.*

	Priorfield.	Stanton.	O.O.O.O.	Awsworth.	Hydrate.	Denby No. 3.
MECHANICAL TESTS.						
Solid contraction on ½ in. bar No. 1	.15	.151	.148	.142	.155	.149
" " " " " 2	.15	.151	.148	.142	.155	.146
Transverse test on ½ in. bar No. 1	370 lbs.	450 lbs.	390 lbs.	420 lbs.	480 lbs.	475 lbs.
" " " " " 2	415 lbs.	470 lbs.	400 lbs.	450 lbs.	480 lbs.	482 lbs.
Deflection test on ½ in. bar No. 1	¼ in.	⅛ in.	⅛ in.	¼ in.	¼ in.	⅛ in.
" " " " " 2	¼ in.	¼ in.	⅛ in.	¼ in.	¼ in.	⅛ in.
Drill test on 1½ in. bar No. 1	76½ revs.	76 revs.	59 revs.	62 revs.	60 revs.	66 revs.
" " " " 2	76½ revs.	76 revs.	58½ revs.	63 revs.	63 revs.	67 revs.
Transverse test on 1 in. bar No. 1	2,380 lbs.	2,632 lbs.	2,212 lbs.	2,352 lbs.	2,464 lbs.	2,408 lbs.
" " " " 2	2,436 lbs.	2,604 lbs.	2,184 lbs.	2,072 lbs.	—	2,408 lbs.
Tensile test per sq. in. No. 1	10.38 tons	Waster	Waster	Waster	10.62 tons	10.5 tons.
" " on 1 in. bar, 2	10.40 tons	12.43 tons	12.69 tons	8.28 tons	10.57 tons	10.61 tons.
ANALYSIS.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Comb. carbon	trace	.207	.234	.254	.172	.104
Graphite	3.000	3.311	2.956	3.182	3.509	3.114
Silicon	2.800	2.800	3.730	2.333	3.406	2.566
Phosphorus	1.202	1.200	1.245	1.652	.840	1.528
Sulphur	.066	.044	.056	.010	.145	.046
Manganese	1.008	.720	.792	.504	.576	.288
Appearance of fracture on "K" test for liquid contraction.	Perfectly solid.	Perfectly solid.	No sink, but slight draw in centre.	Slight sponginess in centre.	Perfectly solid.	No sink, but very slight sponge.

CORRESPONDENCE.

CASTINGS TO STAND INTENSE HEAT.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Seeing the above is not answered in your July issue, permit me to say that if "E. G. W." and others who are in quest of information would give a few more details of what they themselves have been doing, others, doubtless, qualified to assist would the more readily come forward and give their experiences to your various subscribers from time to time. Of course, you can always find some who are in search of information, but a fewer number give it, and, as a rule, the giver seldom hears afterwards as to whether his advice has had the desired effect.

It is a little curious that difficulties of casting usually resolve themselves into materials, whereas, if the truth were known, it would more frequently turn out to be methods and manipulation of materials. Hence the need for a full statement from the parties requiring information, so as to retain former materials, if need be, or *vice versâ*. However, in this particular question it seems to be a question of intense heat, and all is concentrated by your querist as he says: "We have tried several mix-

ings of iron, but find that when the castings are subjected to the heat they invariably break, and the cost of renewals makes the price practically prohibitive."

But, again, the question is ambiguous, because there is nothing stated as to what the castings are, or what duty they have to perform. Therefore they may be pots or pans for lead smelting; retorts for gas manufacturing purposes; fire bars or furnace plates having an abnormal exposure to flames, or any other class of casting having extraordinary heat duty to perform, and where design, at times, has more to do with efficiency than the mixture of metal with which such are cast, because it is "break," not "burned," or "melted" that is the trouble. Besides, in the second paragraph of "E. G. W.'s" letter he asks for "the best way of making these castings, and what you think will be the best mixing to make them from."

Nevertheless, with castings as indicated here, the best results are always obtained from the best irons, never mind the price for the present. It may be said that what to many might appear a little outrageous in cost for pig metal, would in the end become the cheapest to all concerned. Agreement here between buyer and seller, where it is purely a question of metals, would do much to remove some, at least, of the heartburnings on the vexed question of imperfect and bad castings. But aside from the question of metal suitable for castings to withstand the intense heat "E. G. W." refers to, he is likewise asking for "the best way of making these castings." Query, what castings? We have yet to get from him what class his letter in the June issue of the FOUNDRY TRADE JOURNAL, page 256, refers to, and when this is given, those inclining to help him, and others, if need be, will have a chance of doing so.

Yours, etc.,
FERRO.

"WHITE METAL MIXTURE."

This is another question of the ambiguous type, as Mr. James Brown, jun., Perth, fails to mention the mixture of metal he is using for those "plumber's taps" he is casting in white metal, and which seems to be giving him so much trouble, as he puts it, "owing to blow holes in the metal, due to what appears to be shrinkage." Taking it to be a case of shrinkage, his metal may, after all, be quite right; but his methods of treatment in temperature or position may be altogether wrong, not to mention other details of moulding. Without going into details, let it be said in a word that supposing the first of these conditions were all that could be desired, and the mould in the wrong position while casting, all would be absolutely wrong, and instead of getting a casting as expected, scrap would be the result. Only one case in point, although these could be given by the score.

A certain steel valve was cast in one of our best foundries a few weeks ago, and for a number of consecutive castings it proved a waster, all, of course, at first impression, being blamed on the metal. Ultimately it dawned upon the responsible party that the error, which had given the best skill in the shop so much trouble, might after all be a case of shrinkage. This admitted, the person in charge could not see his way to alter any detail of moulding or casting. Therefore he resolved to continue as he had been doing, and add to that a *change of position* for the mould, to "densify" its casting while shrinking. This was done by toppling it over, at the proper time after it was cast, and this had the desired effect of solidifying the spongy part which had hitherto given them trouble. The significance of this operation by simply altering its position to shrink is but another proof of the phenomena attending the abstruse and, at times, mysterious art of founding, and which alone is mastered in proportion to the experience one possesses. So ended all the previous trouble with this casting, as all in turn, when cast, were turned upside down, and whether a better distribution of the solidification of the previously defective part, it matters not, the fact remains that an absolute cure was effected. Consequently, if Mr. Brown, jun., looks beyond the crucible and its contents, he may likewise find out his error of workmanship with those white metal taps, and although the example given was a steel casting, it must never be forgotten that what is common to one metal in shrinking, the same in a greater or less degree is common to all other metals used in founding. The differences being a question of degrees proportioned to the relative densities of the various metals used in the production of machinery castings, coarse or fine; and white metals, as a rule, are more mischievous or erratic in shrinking than any other alloys or metals known to the writer.

Yours, etc.,
FERRO.

THE "LEEDS" COMBINED HAND PRESS AND TURNOVER MOULDING MACHINES.

WHAT was once called the art of making moulds for small castings in quantities is now, through the introduction of machinery, gradually becoming a science, and at the present time, is making rapid strides in this direction.

During the past few years various machines have been made especially adapted for the several classes of work to be done, so that it is almost impossible for a workman of ordinary capabilities to go wrong. For instance, we have the pulley machine for making pulleys; the stripping plate machine for sundry and special jobs where very little taper can be allowed; the pressing machine in its various forms suited to a large range of medium and small light work; and the turnover pattern-drawing machine on which the ramming is done by hand.

The above types of machines form a range suitable for almost any class of castings, either iron, steel, or brass, in small and medium sizes that are required in numbers of one dozen and upwards; and not necessarily being power machines can be employed by the small as well as the large founder; in fact, the small founder with a proper system of hand-operated machines—through his lower first cost and consequent less supervision—can compete very favourably with his larger neighbour who has an expensive power plant installation.

FIG. 1.—THE "LEEDS" MOULDING MACHINE.

That the power machine has its proper and very useful place must be admitted, but for small light work in medium quantities the most economical production is certainly obtained by the use of a good and useful hand-operated machine.

The machine shown in the accompanying illustrations is a combination of press and turnover pattern-drawing machine, which can economically produce almost any kind of casting that comes within its range for size.

All practical foundrymen are well aware

that there is a limit to the sand hanging in the drag of a mould when in an inverted position, and unless special means are provided in the shape of special boxes, rods, etc.—which in any case, mean extra cost—we find a large number of castings, owing to some core or cavity in their formation, unsuitable to mould by raising the drag from the patterns. This is where the turnover machine comes in handy, and as it is still desirable to press the moulds, the machine here illustrated fills the gap exactly.

Now release the drag, rap pattern plate and raise same, leaving the drag on the machine table, whence it is removed to the floor. The pattern plate with pressed cope attached is now turned over, filled, and pressed when the cope is released and removed.

This series of operations, which can be quickly carried out, gives a complete mould off the machine, and leaves a pressed drag on the machine, and the cycle of operations can be repeated as long as necessary. From this it will be seen that a half-mould is made at each

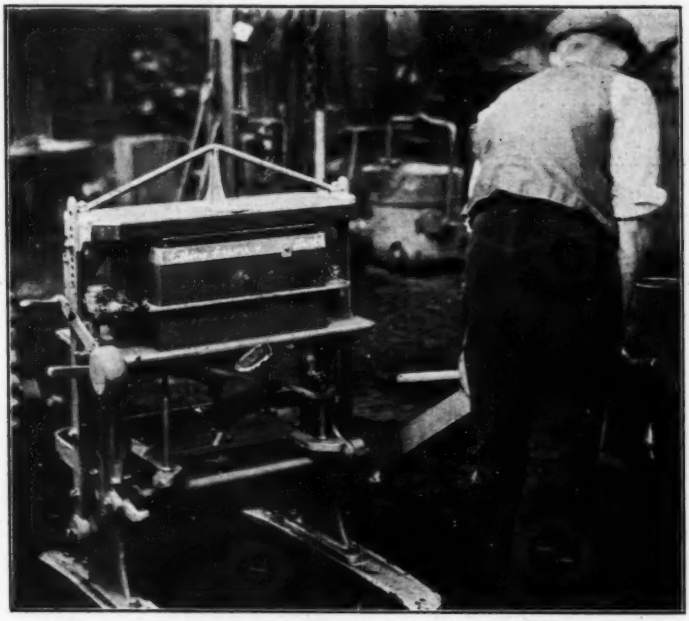

FIG. 2.—THE "LEEDS" MOULDING MACHINE.

Now, if we assume the pattern plate—with a part of the pattern on each side of same—to be mounted on this machine ready for use, then the method of operation is as follows:—Secure the cope to the cope side of pattern plate, then raise, turn over and lower same until it rests on the machine table; this will support the pattern plate while the drag is filled with sand and pressed, the drag being likewise fastened to the pattern plate; the whole is raised, and turned over so that the drag now rests on the table while the cope is filled and pressed.

operation of the machine, and that there is always a half-mould (either cope or drag), supporting the pattern plate while the opposite half is being pressed.

A very large range of work can be done on this machine at a minimum cost for both machine and pattern plates, and from 10 to 18 complete moulds 14 in. by 20 in. can be made per hour.

These machines are supplied by Messrs. Horace P. Marshall & Company, of Leeds, in four distinct types to suit different requirements as follows, viz:—(1). Simple mould press; (2) mould press

with lifter; (3) mould press with turn-over plate; (4) mould press with turn-over plate and lifter.

The latter makes a really useful universal machine, and is recommended where the work may be uncertain in its character; each machine is very simple in operation and adjustment. The "Leeds" series of moulding machines, as they are designated, are already becoming popular in the districts where they have so far been introduced, principally in Lancashire, Yorkshire, and on the East Coast, and we are informed that the demand has considerably increased during the last six months.

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SOURCES OF DROSSES, ASHES, SCRAP, ETC.

MR. L. PARRY, writing in the "Mining Journal," gives the following interesting summary of trade sources of drosses, ashes, scrap, etc :—

Tinplate Manufacturers.—Tin scruff; fine tin ashes; terne ashes; carbonaceous ashes.

Tin Smelters.—Tin dross; hardhead; tin slags..

Lead Smelters.—Poor copper matte; coppery dross; lead slags; antimonial litharge.

Solder Manufacturers.—Solder ashes.

Metal Refiners.—White metal ashes; type ashes; composition ashes; type slags.

Britannia Metal Manufacturers.—Britannia metal ashes.

Anti-Friction Metal Manufacturers.—Babbitt dross.

Antimony Refiners.—Type and antimonial dross.

Lead Pipe and Sheet Manufacturers.—Lead ashes.

Tinsmiths, Tinplate Workers, Manufacturers of Tinned Goods.—Solder ashes; tinplate scrap.

Plumbers.—Lead ashes; solder ashes; waste lead; old brass; cupriferous foundry ashes, scrap, and slags.

Brassfounders.—Solder ashes; tin zinc alloys; white metal ashes; anti-friction metal ashes and scrap.

Engineers, Makers of Machinery.—Anti-friction metal ashes and scrap; brass sweeps and scrap.

Button Manufacturers.—White metal ashes.

Typefounders, Printers (including newspapers).—Type copper; type ashes; type scrap.

Railway Companies, Government Works.—Mixed metal borings and scrap; old bullets; gunmetal ashes and scrap.

Colour Mixers.—Paint skins; red lead; white lead.

Chemical Works.—Tin precipitate; tin oxide; sulphate of lead and copper; lead nitrate; lead acetate.

Manufacturers of Metal Goods.—Mixed metal drosses and scrap; polishing waste; britannia ashes; pewter ashes; brass sweeps and scrap.

Capsule Manufacturers.—Capsule dross.

Wholesale Grocers.—Tea lead.

Wine and Spirit Merchants.—Capsules.

Cyanide Manufacturers.—Lead gruff.

Makers of Accumulators, Makers of General Electrical Plant, Town and County Councils.—Peroxide of lead; battery waste; old accumulators.

Metal Brokers and Dealers.—Hard tin; tin oxide; tin ashes; tin precipitates; tin grease and chalk; polishing waste and powder; tin copper mattes and alloys; irony tin dross (South American); tin ore sweepings; pewter ashes and type ashes.

Metal Polish Manufacturers.—Polishing waste.

Metallic Packing Manufacturers.—Babbitt dross.

Electroplaters.—Cyanide refuse holding silver, gold, copper, nickel.

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THE reduction of the capital of the British Westinghouse Electric and Manufacturing Company, Limited, from £3.250,000 to £1,875,000, has been sanctioned.

THE extension scheme recently embarked upon at the works of Messrs. Cowan, Sheldon & Company, Carlisle, is now assuming definite shape. A huge ironwork structure has been erected which will nearly double the area of the firm's floor space, and is being equipped with overhead travelling cranes of Messrs. Cowan, Sheldon's own make.

IN reply to a question in the Commons as to the exports to British possessions of articles completely manufactured, whether the principal items and Colonies which accounted for the decline from £46,500,000 in 1903 to £41,200,000 in 1904 could be stated, the President of the Board of Trade has replied: The principal items are certain iron and steel manufactures, steam engines, railway wagons, etc. Practically the whole of the decline in question occurred in exports of these articles to South Africa.

FERRO-SILICON ADDITIONS TO MOLTEN CAST IRON.

We have previously referred to the results secured by Mr. A. E. Outerbridge, of Philadelphia, in the use of powdered ferro-silicon introduced in ladles of molten cast iron. An American patent has been granted Mr. Outerbridge on the application of this method. Mr. Outerbridge explains that his invention depends upon the following characteristics: (1) that the silicon compound shall be readily diffusible throughout the metal in the ladle at the temperatures employed in foundry practice; (2) that the vehicle shall not substantially impair the resultant product.

Experience shows, it is stated, that additions of ferro-silicon in the cupola are not only wasteful of the ingredients, but result in irregularity. The results obtained by the addition of ferro-silicon and the method of using it are stated in the patent as follows:—

"I can produce in the ladles themselves a great variety of grades of iron with respect to hardness, chilling properties, and other important characteristics, so that the general run of iron in the cupola need not be practically varied, and may, moreover, be of what would be termed a 'low' grade, the necessary treatment to control the physical qualities being restricted to the relatively small quantity commonly used in a foundry ladle and the changes within the desired limits being immediately attainable. By this means I am enabled to cast from the same cupola charge small articles, such as pulleys with rims, say, ¼ in. thick, soft enough to permit of machining, and with negligible chilling tendency, and heavy castings having, if desired, high chilling properties and close grained texture.

"In carrying out my process I proceed as follows:—I may melt in the cupola iron of a character capable for the castings of the lowest grade to be made, which may have close-grained texture and high chilling properties, and then tap into a ladle a charge sufficient for a particular casting or group of castings which it is desired to make of softer iron having but little chilling tendency. I then combine with the molten metal in the ladle a definite amount of a silicon compound in such form as to be thoroughly and quickly diffusible and without attendant additions which would impair the desired result. For this purpose I prefer to use powdered ferro-silicon containing a large proportion of silicon—say, 50 per cent. of silicon—and I usually add it at the time of tapping the metal into the ladle, or soon thereafter in order to insure thorough combination. The casting is then poured in the usual manner. Other ladles may be tapped from the same charge and treated with different quantities of ferro-silicon, depending upon the qualities desired for the ultimate product.

"I have found that hard iron can be modified so as to produce a relatively soft grey iron by the addition of even so little as 1 lb. of 50 per cent. ferro-silicon to 200 lbs. of iron, and that within certain limits the desired physical characteristics of the metal can be accurately controlled in correspondence with the percentage of the ferro-silicon thus added.

"I have named 50 per cent. ferro-silicon as the preferred ingredient to be practically used, because it affords the desired vehicle for the introduction of the silicon (which is the efficient agent) under such circumstances as are most favourable for the end to be obtained. If a low grade of ferro-silicon be added (containing, say, only 20 per cent. of silicon), the relatively large amount of iron contained in the addition tends not only to chill the contents of the ladle, but may in itself injuriously modify the total mass with relation to its intended purpose. Moreover, under these circumstances the addition does not exhibit the immediate and thorough diffusibility which characterises the relatively high-grade ferro-silicon and which is essential for the practical conduct of the operation, since it will be noted that the addition is made after the cessation of the actual melting process and that the reaction must be effected during the period when cooling is taking place."

It is, of course, nothing new to use ferro-silicon in molten cast iron.

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Mr. A. G. Cuthbert, Irish representative of Crompton & Company, Limited, has been placed in charge of their Manchester district, with offices at Woodall's Buildings, No. 42, Deansgate, Manchester.

At a recent meeting of the London County Council, the Highways Committee recommended the acceptance of the tender of Hadfield Steel Foundry Company, Sheffield, at £967 5s., for special steel track work.

THE MALLEABLE FOUNDRY.*

By Dr. Richard Moldenke.

Hardly a week passes but that I receive enquiries regarding the cost of establishing malleable castings plants. The answer I have to write invariably is :— "Unless you have at least 5 tons daily to make—don't."

As a rule the requests for information come from those iron foundries which get orders for plenty of grey iron castings with a sprinkling of malleable, and possibly some steel castings also. The high price they have to pay outside for small lots naturally interferes with their legitimate profit, and hence the desire to produce for themselves. I believe that when the electric furnace is perfected, or made commercially possible, a different aspect will be given to the case, but at present we have to take things as they are.

Those concerns which use a large quantity of these castings are the natural pioneers for a given region. The fact that they can make money where they are, would be a pretty good guarantee that they can either save money or get their desired deliveries by going into the malleable casting business. Moreover, their profit as manufacturers will carry them over the two or more years of loss in starting the malleable plant.

Favourable Factors.

To sum up briefly the advantages, I give the following :—

1. The expanding market for malleable castings, and the great room for improvement in most of the producing works, gives a living chance to the man to go in the business, provided he understands it thoroughly.

2. In times of prosperity, plants in existence, where great caution is exercised, must turn away large quantities of offered work, being unable to produce it.

3. The moment the malleable castings works are full, deliveries are so desperately bad and slow that attention is turned directly to new enterprises coming in.

4. The adaptability of the malleable casting to specialities in railroad, agricultural and hardware lines is such that the beginner has a good chance to succeed provided his speciality is good.

5. Where absolutely good material is required it pays the consumer of malleable castings to go into making these himself, provided he has enough tonnage. Only he who knows how easily one can slip up on the quality of the malleable casting also knows how often this is done, and the customer is not the wiser.

6. The malleable product from its adaptability to specialities, and comparatively light castings at that, means a production in quantity of each separate piece. Hence it is not a question of half a dozen castings, but oftentimes several hundred thousand, or, in other words, continuous production, with comparatively well regulated and systematised shop cost.

The Drawbacks.

Now the disadvantages follow from the above :—

1. The expanding market, while making room, also leaves very empty shops in dull times, for the existing plants usually expand with each high wave of prosperity and manage to hold the desirable customers.

2. Where the work turned away by the full plants is taken by the beginner it is at lower prices, or if at high prices, is lost again when these fall. Ability to hold customers who may have been exasperated elsewhere, or ability to produce cheap enough to cut under, or most likely having a speciality which pays the freight, will make or break the new malleable plant.

3. The capital required is a great detriment, being about four times as much as for the same tonnage in grey iron for works alone. The malleable casting process is intricate, the chances of loss great, and it takes fully two years to get a desirable class of men in the shop. Hence the chances of no profit, if not worse, for a long time. A rough calculation of the cost of a shop to produce 50 tons of castings daily would come up to, say, $250,000. By the time that shop would be actually producing the 50 tons daily at a normal shop cost, over double the amount of money will have been expended. Then, however, with a good market the shop will pay handsomely.

4. The high grade of skill required. With the range of composition for the iron for various thicknesses of the castings very close, a white iron to start with, with its double contraction and danger of shrinkage in the interior, with the necessity of chills, the limit to the size and weight, the expansion in the anneal, etc., it is a pretty delicate task

* Paper read before the American Foundrymen's Association.

to turn out large quantities of various classes of castings and have them all high-grade. Hence the high salaries the important men must be paid and the eternal vigilance required in the works. It must be remembered that your day's work goes into the anneal and you do not see it for a week. The next day's work the same, and hence a mistake in the temperature of the ovens, and you have ruin for possibly a week before you find it out. I remember the slipping off of the night annealer to a near-by speak-easy, with the increase in the natural gas pressure just at that time, which meant thousands of dollars of damage for two or three hours' inattention.

5. The fierce competition that is met. This is primarily the case, because to run a shop successfully and to hold an expensive organisation everybody must be busy. The first aim, therefore, is tonnage, to keep the shop producing at maximum capacity all the time, practically regardless of prices sometimes. Hard times drop prices in the malleable shop far more quickly than in the grey iron establishment. I remember the time when castings were sold to the railroads at a shade less than 2 cents a pound, delivered. When it is remembered that malleable castings ought to bring a cent a pound more than the corresponding grey ironwork it will be seen what a new man is up against in starting when prosperity is on the wane.

The further reason for this fierce competition is that nearly everybody in this line has a speciality, or several of them, which sell under patents and for as high a price as the community will stand. Hence this velvet can cover a deficit to keep the rest of the works in operation. This, of course, is hard on the man who has no speciality, and hence, again, the necessity of having abundant capital until such a speciality is found.

To sum up. With a good speciality, or a number of castings used in the manufacture of well-paid-for articles, and a sufficient daily tonnage, it is good policy to go into the malleable casting industry as a business venture; but with less than 5 tons daily safe, and with insufficient working capital and men not thoroughly trained in this line it is better to let it alone.

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A DISSOLUTION of partnership is notified in connection with Messrs. J. E. King, H. E. Wadsworth, and J. Dovener, engineers, etc., Leeds.

NEW BOOK ON FOUNDRY PRACTICE.

MESSRS. ANDREW MCWILLIAM, A.R.S.M., and Percy Longmuir have just written a new book entitled "General Foundry Practice." It is published by Messrs. Chas. Griffin & Company, of Exeter Street, London, W.C., and will be a welcome addition to the none too voluminous literature of the science and practice of founding. The credentials of its authors are unimpeachable; their names are a *primâ facie* guarantee that the theoretical and practical sides of the subject will be adequately dealt with. Confirmation of this is quickly afforded by a perusal of the volume before us. In arranging their matter the authors have wisely placed the practical section first, the metallurgical branch of the subject being dealt with in the latter portion of the book. It would be impossible to read these pages without realising what great advances have been made, not only in the art of producing castings, but in the investigation of the structure and behaviour of the different metals from which they are made. While in any treatise on founding claiming to be comprehensive it must necessarily happen that many of its contents bear a familiar look, there are, nevertheless, many pages in this work which not only deserve but demand the attention of modern foundrymen.

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ANALYSES OF BRITISH PIG-IRON.

WE have complied for the use of our readers analyses of nearly all the principal makes of iron which are sold in large quantities on the market. Such analyses are, of course, necessarily supplied by the makers themselves, and therefore are likely in many cases to put the best side foremost. At the same time the analyses are of great interest and value. We should welcome any discussion or results of experience with the irons enumerated. Analyses of other irons will be continued in subsequent issues.

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MESSRS. T. HARDING CHURTON & COMPANY, Atlas Works, Leeds, have appointed Messrs. Andrews & Company, 198A, St. Vincent Street, Glasgow, as their agents in Scotland.

ANALYSES OF BRITISH PIG-IRON.

CUMBERLAND.

James Bain & Co.,

HARRINGTON, CUMBERLAND.

Brand—"Harrington."

	G.C.	C.C.	Si.	S.	P.	Mn.
Hematite—						
No. 1 ...	—	—	2.00-3.00	tr. to 0 025	0.04	—
„ 2 ...	—	—	1.80-2.80	0.015-0.035	0.04	—
„ 3 ...	—	—	1.75-2.50	0.045-0.050	0.04	—
„ 4 ...	—	—	1.24	0.075	0.04	—

Distington Hematite Iron Co., Ltd.,

DISTINGTON, CUMBERLAND.

Brand—"Distington."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 ...	3.460	0.360	2.00-3.00	tr. to 0.025	0.035-0.045	0.180
„ 2 ...	3.420	0.400	2.00-3.00	tr. to 0.030	0.035-0.045	0.180
„ 3 ...	3.370	0.450	2.00-3.00	tr. to 0.035	0.035-0.045	0.180

Kirk Bros. & Co., Ltd.,

WORKINGTON.

This Company's output is all used by themselves.

Millom & Askam Hematite Iron Co., Ltd.,

MILLOM.

Brand—"Millom."

	G.C.	C.C.	Si.	S.	P.	Mn.
Special...	3.75	0.18	1.00-3.00	Max. 0.025	Max. 0.025	0.50
No. 1 ...	3.75	0.18	1.00-3.00	tr. to 0.030	0.030	0.50-0.80
„ 2 ...	3.48	0.19	1.00-3.00	tr. to 0.030	0.031	0.50-0.80
„ 3 ...	3.22	0.25	1.00-3.00	tr. to 0.030	0.031	0.50-0.80
„ 4 ...	2.72	0.59	1.20	0.10	0.034	0.60
„ 5 ...	2.60	1.33	0.90	0.13	0.034	0.40
Mottled	1.50	1.70	0.55	0.13	0.036	0.25
White ...	0.10	3.00	0.56	0.15	0.038	0.20

Brand—"M.H.M."

	G.C.	C.C.	Si.	S.	P.	Mn.
White ...	0.11	3.00	0.50	0.15	0.037	0.20
Spotted white	0.10	3.10	0.60	0.16	0.037	0.20
Hard mottled	2.60	0.77	0.94	0.20	0.036	0.20
Soft mottled	2.10	0.74	0.74	0.16	0.036	0.20
Grey ...	2.40	1.00	1.20	0.13	0.036	0.20

Brand—"Askam."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 ...	3.50	0.20	1.00-3.00	tr. to 0.03	0.035	0.50-0.70
„ 2 ...	3.40	0.21	1.00-3.00	tr. to 0.03	0.035	0.50-0.70
„ 3 ...	3.26	0.30	1.00-3.00	tr. to 0.03	0.035	0.50-0.70
„ 4 ...	2.56	0.70	1.30	0.10	0.036	0.50-0.70
„ 5 ...	2.20	1.20	1.00	0.14	0.038	0.80
Mottled ...	1.50	1.60	0.60	0.15	0.039	0.19
White ...	0.30	2.80	0.49	0.16	0.040	0.20

Moss Bay Hematite Iron & Steel Co., Ltd.,

WORKINGTON, CUMBERLAND.

Brand—"Moss Bay."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 B	3.60	0.10	3.00	0.01	0.03-0.04	0.70
„ 2 B	3.50	0.15	2.50	0.02	0.04	0.70
„ 3 B	3.30	0.25	2.00	0.04	0.04	0.6
Forge 3	3.00	3.35	1.70	0.07	0.04	0.50
„ 5	2.80	0.45	1.30	0 10	0.04	0.50

Whitehaven Hematite Iron & Steel Co., Ltd.,

CLEATOR MOOR, CUMBERLAND.

Brand—"Cleator."

	G.C.	C.C.	Si.	S.	P.	Mn.
Average analysis ...	2.993	0.320	1.931	trace	0.041	trace

DERBYSHIRE.

Clay Cross Co.,

NEAR CHESTERFIELD.

Brand—"Clay Cross."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1	2.47	0.64	3.33	0.02	0.54	0.21

E. P. Davis,

BENNERLEY FURNACES, ILKESTON.

Brand—"Awsworth."

	G.C.	C.C.	Si.	S.	P.	Mn.
Foundry open	3.00	0.10	3.00	0.006	1.30	0.30

Denby Iron & Coal Co., Ltd.,

NEAR DERBY.

Brand—

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 3	2.98	trace	2.67	0.06	1.45	0.76

James Oakes & Co.,

ALFRETON, DERBYSHIRE.

Brand—"OOOO."

	G.C.	C.C.	Si.	S.	P.	Mn.	Arsenic.	Chromium.
No. 2 Foundry	3.60	0.59	1.659	0.026	1.139	0.755	0.012	—
„ 3 „	3.57	0.53	1.505	0.024	1.196	0.805	0.012	—
„ 4 „	3.34	0.25	2.920	0.043	1.709	0.670	—	0.139
„ 4 Forge...	2.11	1.00	2.520	0.090	1.020	0.100	—	0.132
Grey „ ...	3.14	0.40	2.280	0.070	0.940	0.860	—	0.108

ANALYSES OF BRITISH PIG-IRON—*continued.*

Renishaw Iron Co., Ltd.,
ECKINGTON.

Brand—"Renishaw."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.410	trace	2.939	0.036	1.080	0.362
,, 2 ,, ...	3.260	0.179	2.146	0.034	1.623	0.707
,, 3 ,, ...	3.850	0.112	2.333	0.024	1.581	0.572
,, 4 ,, ...	3.300	0.225	2.099	0.053	1.771	0.647
Close Forge ...	2.800	0.330	1.819	0.079	1.730	0.520
Mottled	1.550	1.560	1.200	0.200	1.500	0.350
White	2.650	0.100	0.450	0.250	1.350	0.250
Glazy	3.460	trace	4.500	0.070	1.600	0.610

Sheepbridge Coal and Iron Co., Ltd.,
CHESTERFIELD, DERBYSHIRE.

Brand—"Sheepbridge."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.74	0.08	3.17	0.01	1.40	0.89
,, 2 ,, ...	3.50	0.12	3.20	0.02	1.43	0.88
,, 3 ,, ...	3.25	0.24	2.80	0.03	1.44	0.85
,, 4 ,, ...	3.10	0.30	2.68	0.04	1.44	0.88
,, 4 Forge ...	2.80	0.60	2.10	0.06	1.45	0.88

Stanton Iron Works Co., Ltd.,
NR. NOTTINGHAM.

Brand—"Stanton."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.38	0.06	3.24	0.028	1.20	0.49
,, 2 ,, ...	2.85	0.05	3.50	0.029	1.02	0.40
,, 3 ,, ...	3.25	0.31	3.39	0.013	1.16	0.46
,, 4 ,, ...	2.32	0.67	2.91	0.065	1.19	0.48
Forge	1.48	1.26	1.66	0.091	1.24	0.38
Mottled	1.28	0.85	0.97	0.230	0.85	0.75
Tiger	1.25	1.40	1.24	0.300	1.22	0.23
White	0.60	1.70	0.47	0.410	1.08	0.13

Staveley Coal and Iron Co., Ltd.,
NR. CHESTERFIELD.

Brand—"Staveley."

	G.C.	C.C.	Si.	S.	P.	Mn.
Broad Oaks Furnaces—						
No. 1 Foundry ...	3.06	0.22	3.27	0.02	1.29	0.74
,, 2 ,, ...	3.16	0.27	3.52	0.05	1.24	1.06
,, 3 ,, ...	3.12	0.31	3.09	0.05	1.35	0.93
,, 4 ,, ...	3.12	0.29	2.68	0.07	1.27	1.73
,, 4 Grey Forge	3.16	0.25	2.38	0.07	1.40	1.73
,, 4 Forge ...	3.18	0.33	3.27	0.08	1.45	0.97
,, 4 ,, ...	0.12	0.37	2.01	0.11	1.35	0.93
Staveley Works—						
No. 1 Foundry ...	3.30	0.30	3.08	0.03	1.43	1.22
,, 2 ,, ...	3.16	0.27	2.80	0.04	1.58	0.85
,, 3 ,, ...	3.12	0.31	2.50	0.04	1.49	1.12
,, 4 ,, ...	3.12	0.29	2.45	0.07	1.27	0.97
,, 4 Grey Forge	—	—	2.40	0.08	1.41	1.35
,, 4 Forge ...	3.40	0.32	3.38	0.08	1.40	0.95
,, 4 ,, ...	2.92	0.58	1.61	0.12	1.42	0.80
,, 5 ,, ...		Same	as	No. 4	Forge	
Mottled	2.18	1.08	0.96	0.19	1.44	1.50
White	0.90	3.10	0.45	0.15	1.36	1.33
Glazed	—	—	4.50	—	—	—

DURHAM.

Bell Bros., Ltd.,
CLARENCE IRON WORKS, MIDDLESBROUGH.

Brand—"Clarence."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.30	0.15	2.90	0.030	1.52	0.60
,, 3 ,, ...	3.40	0.18	2.50	0.035	1.52	0.60
,, 4 ,, ...	2.80	0.48	2.31	0.075	1.55	0.50
,, 4 Forge ...	3.00	0.62	1.53	0.142	1.50	0.45
Mottled	2.50	0.87	1.31	0.153	1.50	0.33
White	trace	3.10	0.93	0.250	1.52	0.30
Silicious	3.30	trace	4.22	0.016	1.55	0.70

The Carlton Iron Co., Ltd.,
CARLTON IRON WORKS, FERRY HILL.

Brand—"Carlton."

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.290	0.057	3.190	0.038	1.290	0.320
,, 3 ,, ...	3.240	0.110	2.770	0.030	1.360	0.250
,, 4 ,, ...	2.190	0.164	2.330	0.035	1.320	0.320
,, 4 Forge ...	2.030	0.363	2.120	0.094	1.180	0.250
Mottled	2.050	1.250	1.790	0.190	1.450	0.320
White	0.120	3.100	0.880	0.280	1.400	0.300
Glazy	3.080	0.020	5.120	0.010	1.090	0.250

Consett Iron Co., Ltd.,
CONSETT, CO. DURHAM.

This firm only sell small quantities of pig-iron.

Palmer's Shipbuilding and Iron Co., Ltd.,
JARROW-ON-TYNE, DURHAM.

Brand—"Jarrow," Cleveland.

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.65	0.10	3.00	0.020	1.100	0.55
,, 2 ,, ...	3.45	0.25	2.50	0.032	1.100	0.55
,, 3 ,, ...	3.25	0.30	2.25	0.045	1.100	0.50
,, 4 ,, ...	2.90	0.50	1.80	0.065	1.150	0.40
,, 4 Forge ...	2.90	0.56	1.60	0.080	1.200	0.40

Brand—"Tyneside," Hematite.

	G.C.	C.C.	Si.	S.	P.	Mn.
No. 1 Foundry ...	3.95	0.15	2.30	0.025	0.038	1.75
,, 2 ,, ...	3.75	0.27	1.85	0.035	0.038	1.60
,, 3 ,, ...	3.45	0.35	1.50	0.055	0.040	1.40
,, 4 ,, ...	3.10	0.55	1.15	0.080	0.040	1.05

The Seaton Carew Iron Co., Ltd.,
WEST HARTLEPOOL.

Brand—"S.S.F."

	G.C.	C.C.	Si.	S.	P.	Mn.
Refined cylinder iron	2.75	0.90	0.90	0.09	0.35	0.50

Brand—"S.C.M."

	G.C.	C.C.	Si.	S.	P.	Mn.
Malleable iron—						
Grey	2.90	0.60	1.50	0.12	0.05	0.40
White	0.20	3.25	0.40	0.22	0.05	0.25

TRADE TALK.

J. H. Wilson & Company, Limited, have removed to Dock Road, Seacombe, Birkenhead.

A compulsory winding-up order has been made against the Dorinda Engineering Works, Limited.

The David Kimberley & Sons' Tool Manufacturing Company, Limited, is in voluntary liquidation.

Messrs. J. Harrop, C. Harrop, and J. Benson, engineers, Pontardulais, have dissolved partnership.

Messrs. F. Greaves and G. F. Siddall, fender manufacturers, etc., Sheffield, have dissolved partnership.

Messrs. F. R. B. Price & G. T. Adams, general engineers, Tunbridge Wells, have dissolved partnership.

Messrs. R. T. Palmer and J. W. Booth, ironfounders, Burnham-on-Crouch, have dissolved partnership.

Messrs. Henry Pels & Company have removed to Lincoln's Chambers, 9, Portsmouth Street, Lincoln's Inn Fields, W.C.

Altenbach, Limited, of Brighouse, Yorks, have appointed Mr. F. S. Dudgeon, M.Inst.C.E., as their London agent.

The registered offices of the Tredegar Iron and Coal Company, Limited, have been removed to 60, Fenchurch Street, London, E.C.

Richardsons, Westgarth & Company, Limited, have removed their London offices to 5, Queen Anne's Gate, Westminster, S.W.

The Blyth Shipbuilding Company, Limited, have removed their offices to the Quayside, near Gregory Street, Cowpen Quay, Blyth.

Mr. T. L. Davidson, Scottish representative of Holden & Brooke, Limited, Manchester, has removed to 62, Robertson Street, Glasgow.

Messrs. J. S. Lord and G. S. Lord, engineers, etc., Whitefield, Lancashire, trading as Spencer & Sons, notify a dissolution of partnership.

Messrs. Harris, Lee & Company, engineers, Johannesburg, have removed their London offices to 55, Berners Street, Oxford Street, W.

McPhail & Simpson, Limited, of Wakefield, have acquired the business of the McPhail & Simpsons' Dry-steam Patents Company, Limited.

Cochrane & Company, Woodside Ironworks, near Dudley, are supplying 4-in. cast-iron pipes, at £5 11s. 6d. per ton, to the Nantwich Rural District Council.

Mr. E. A. Beaumont and Mr. T. H. Oldfield, Huddersfield, have been appointed joint liquidators of Doughill's Engineering Company, Limited, Leeds.

Messrs. Wheatley, Kirk, Price & Company, engineering valuers and auctioneers, have opened offices at 26, Collingwood Street, Newcastle-on-Tyne.

Mr. W. R. Rothenberg, of the Electro-Motor and Dynamo Company, has joined Messrs. E. P. Allam & Company, of 11, Red Lion Street, Clerkenwell Road, London, E.C.

Beyer, Peacock & Company, Limited, of Manchester, have secured a contract for the supply of 50 locomotives for the New South Wales railways, valued at close upon £250,000.

Messrs. Robinson & Jones, 21, Collingwood Street, Newcastle-on-Tyne, have been appointed representatives for the North of England for Brown, Boveri & Company, Limited.

Mr. A. W. Warner, of Norton, near Stockton-on-Tees, has been admitted into partnership in the firm of A. Haacke & Company, boiler and pipe covers, etc., Homerton, London, N.E.

John Brown & Company, Limited, of the Atlas Works, Sheffield, have purchased from Mr. Shakespeare the Trent Iron Works, Scunthorpe, and the business connected therewith.

J. C. Lyell & Company, Limited, engineers, 55, Victoria Street, Westminster, S.W., have been appointed sole buying agents by Messrs. C. & T. T. Pattison, engineers, etc., of Naples, Italy.

A rumour has gained currency of late that the Stirling Boiler Company's extensive works at Motherwell will be transferred to Renfrew, and be merged in the undertaking of Babcock & Wilcox, Limited.

Owing to their inability to get goods conveyed to and from the quays and railways at Belfast, Messrs. Combe, Barbour & Combe, engineers, have been obliged to close a considerable portion of their works.

The Consett Iron Company, Limited, have appointed Mr. F. W. Jackson (who already represents them in the Man-

chester district) their agent for the Midland district, with offices at 3, New Street, Birmingham.

THE UNBREAKABLE PULLEY AND MILL GEARING COMPANY, LIMITED, West Gorton, Manchester, have appointed the Engineering and General Equipment Company, 9, Scale Lane, Hull, sole agents for Hull and district.

W. & T. AVERY, LIMITED, Soho Foundry, Birmingham, have secured a repeat order from the New South Wales Government for twelve 20-ton weighbridges, fitted with their patent protection bar for preserving the graduations on the steelyards.

MESSRS. HODGSON, WRIGHT & WOOD, Century Works, Halifax, have appointed Messrs. Fletcher & Eaton, 79, West Regent Street, Glasgow, as their agents in Glasgow, and Messrs. Norrie & Company, 7, Ward Road, Dundee, as agents for the East Coast of Scotland.

THE STAHLWERKS VERBAND AKTIEN GESELLSCHAFT, in Düsseldorf, have terminated their agency contract with the German Steel Works Union Agency, Limited, and have arranged for the agency being conducted by a new company, styled the Stahlwerks Verband's British Agency, Limited, 13 to 14, Abchurch Lane, London, E.C.

NUMEROUS questions have been asked in the House of Commons during the past month by Mr. H. C. Lea regarding the alleged defective rudder supplied by the Ayrshire Foundry Company for H.M.S. "King Edward VII." some years ago. The member for St. Pancras has been most persistent in his attack on the Company, notwithstanding the repeated explanations by the Premier and the Secretary to the Admiralty, who early recognised the uselessness of raking up ancient matters that took place long before they came into power, that were efficiently dealt with by the authorities responsible at the time, and that had quite recently been investigated by the Public Accounts Committee. Mr. Lea has not only tenaciously attacked the Company, as such, but has included the individual directors and officials in the range of his hostilities, particularly Mr. J. B. Smith, who, as we notify in another column, recently had the honour of knighthood conferred upon him, and who, it appears, was a director of the Ayrshire Foundry Company at the time of the alleged fraud. The Secretary to the Admiralty, in the course of his replies, said that the question of a prosecution was carefully considered, but the law officers of the Crown, under all the circumstances, advised against that course. The firm in question was struck off the contractors' list and the running contract cancelled. The Admiralty was first informed of the defect by a person who had been employed as works manager by the Ayrshire Foundry Company, but had left the firm's employment at the time of furnishing the information. According to his own statement, he had known for many months of this defect, and had himself, although under protest, assisted in concealing it. In the circumstances it did not appear to the Board of Admiralty of the day that he ought to be rewarded, and no reward had been made. The staff of Admiralty inspectors consisted of persons of long experience in foundry work, and he was informed that the defect could not have been detected by visual inspection. The Prime Minister, replying to several questions, remarked that Sir James Smith was a man entirely worthy of the recognition which his public services had received, and enjoyed the respect of all who knew him, to whatever class or party they belonged. He had enquired and found that he was a director of the Ayrshire Foundry Company at the time when the circumstances referred to occurred. But he and his fellow directors had no knowledge whatever of the offence which was being committed by their servant or servants, and for which they themselves had suffered a heavy pecuniary loss. The law officers of the Crown, after careful consideration, declined to take any action against the Company.

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DEATHS.

MR. F. BATTY, a director of Hornsby & Sons, Limited, engineers, Grantham.

MR. T. ANDREWS, head of Messrs. Thomas Andrews & Company, iron manufacturers, of Wortley.

MR H. SUMMERHILL, of Parkdale, Wolverhampton, aged 80 years. The deceased was formerly manager of the old Osier Bed Iron Works.

MR. J. J. TYRRELL, who retired from the position of works manager to Clayton & Shuttleworth, Limited, Lincoln, a few years ago, at the age of 74 years.

MR. W. DOBSON, of The Chesters, Jesmond, aged 74 years, a member of the

firm of William Dobson & Company, shipbuilders, Walker, and also a director of the Wallsend Slipway and Engineering Company, Limited.

MR. J. WADDINGTON, engineer and ironfounder, of Barrow, aged 70 years. The deceased, along with his brother-in-law (Mr. Longbottom), erected works at Barrow 47 years ago, and made frequent extensions to them.

MR. E. SMEDLEY, of Derby Road, Belper, who, along with his brother, Mr. John Smedley, J.P., of Derby, founded the Park Foundry at Belper, where employment was found for several hundred men. About ten years since the concern was made into a limited company.

MR. T. M. HEWITT, sole proprietor of the firm of J. Marsden & Company, Britannia Foundry, Folds Road, Bolton, aged 74 years. The deceased gentleman is succeeded by his son, Mr. H. W. Hewitt, who has been connected with the business for twenty-three years.

MR. W. G. BAGNALL, of Dean's Hill, Stafford, the principal of the Castle Engine Works, Stafford. The deceased gentleman belonged to the well-known Bagnall family, which has been associated with the iron trade of South Staffordshire for generations. He was 55 years of age.

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PERSONAL.

THE late Sir Charles Mark Palmer, M.P., left unsettled property of the gross value of £3,423.

MR. E. BARNES, M.P., has been re-elected secretary of the Amalgamated Society of Engineers.

MR. T. WILKINSON, chairman and managing director of William Cooke & Company, Limited, has successfully undergone an operation.

THE late Mr. J. D. Ellis, chairman and formerly joint managing director of John Brown & Company, Limited, left estate valued at £60,752 gross.

THE RIGHT HON. LORD PIRRIE, chairman of Harland & Wolff, Limited, has been elected a director of the London and South-Western Railway Company.

MR. A. S. PURDON, MR. G. W. SIVEWRIGHT, MR. M. FURNESS, and MR. J. E. FURNESS have been elected directors of Furness, Withy & Company, Limited.

MR. A. JACK has retired from the firm of Marshall, Fleming & Jack, engineers, Motherwell, and the business will in future be carried on as Marshall, Fleming & Company.

SIR ALEXANDER KENNEDY and MR. J. F. ASPINALL, general manager of the Lancashire and Yorkshire Railway Company, have received respectively the degrees of Doctor of Engineering, and Master of Engineering, of the University of Liverpool.

MR. R. H. MEASURES has resigned the managing directorship of Measures Brothers, Limited, but will retain a seat on the Board. Mr. R. T. Measures has been elected chairman, and he and Mr. H. J. T. Measures, have been appointed joint managing directors.

AMONGST the honours bestowed on the occasion of the King's official birthday, we note a peerage conferred upon the Right Hon. Sir James Kitson, Bart., M.P., chairman of the Monksbridge Iron and Steel Company, Limited, and head of Kitson & Company, Limited, Airedale Foundry, Hunslet, Leeds. Sir James has taken the title of Baron Airedale of Gledhow, in the West Riding of the county of York. Mr. Walter Scott, who received a baronetcy, is chairman of Walter Scott, Limited, colliery owners and iron and steel manufacturers, and a director of several other coal and iron companies. Mr. A. M. Carlisle, summoned to the Privy Council of Ireland, is managing director of the shipbuilding firm of Harland & Wolff, Belfast, of which his brother-in-law, Lord Pirrie, is the chairman. Mr. J. B. Smith, a new knight, is a member of the firm of Smith & Wellstood, ironfounders, of Glasgow, London, and Dublin.

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LIST OF NEW INVENTIONS.

Specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Chartered Patent Agent, 77, Colmore Row, BIRMINGHAM.

12,372. Improvements relating to the moulding boxes of moulding machines. W. GROSSMAN.

12,565. Improvements in moulds. P. T. BURKHOLDER.

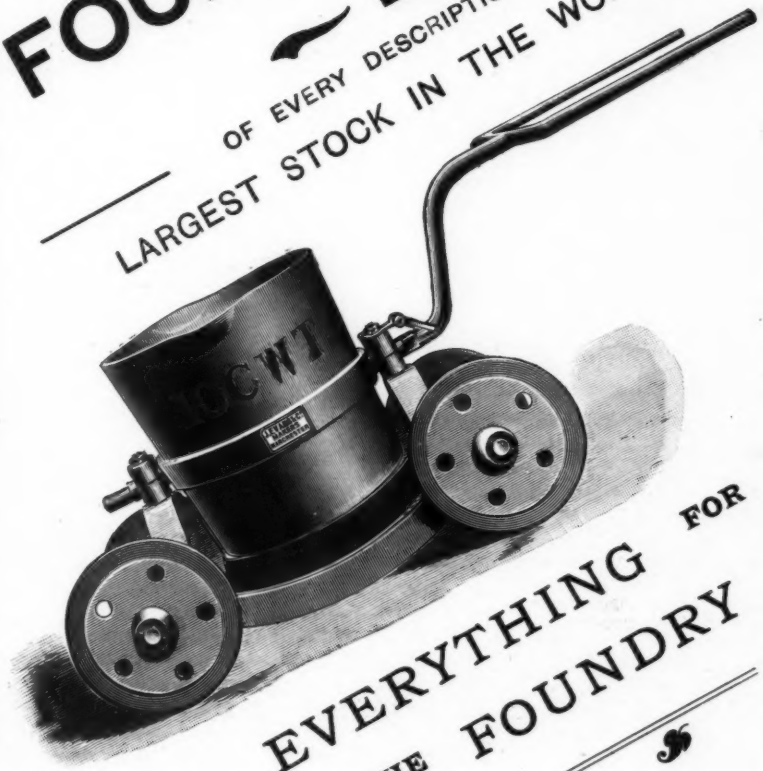
12,955. Improved plant for the casting of metals and other materials. B. Platschick.

Contractors to H.M. Government.

FOUNDRY LADLES

OF EVERY DESCRIPTION.

LARGEST STOCK IN THE WORLD.



EVERYTHING FOR THE FOUNDRY

JAMES EVANS & CO.,

Telegrams:
"LADLES, MANCHESTER."
"BLACKINGS, GLASGOW."

BRITANNIA WORKS, MANCHESTER.

NEW COMPANIES.

ROYCROFT ENGINEERING SYNDICATE, LIMITED.—Capital £100. Registered office: 137½, King Street, Hammersmith, London, S.W.

LINES & COMPANY, LIMITED.—Capital £5,000, to carry on the business of iron-founders, etc. Registered office: 18, College Street, Northampton.

CHISWICK IRON WORKS AND ERECTING COMPANY, LIMITED.—Capital £3,000, to acquire the business of the Chiswick Iron Works and Erecting Company.

JOHN HANDS & SONS, LIMITED.—Capital £25,000, to acquire the founders' business carried on at Cardigan Works, Birmingham, as John Hands & Sons.

WILLIAM WHITTAKER & SONS, LIMITED.—Capital £15,000, to acquire the engineering business of William Whittaker & Sons, Sun Iron Works, Oldham.

BOOTH & BROOKES, LIMITED.—Capital £10,000, to carry on the business of iron founders, etc. Registered office: Mildmay Iron Works, Burnham-on-Crouch, Essex.

STERLING METALS, LIMITED.—Capital £2,000, to carry on the business of metal founders, etc. Registered office: Bank Chambers, Newdegate Place, Nuneaton.

THORNEWILL & WARHAM, LIMITED.—Capital £40,000, to acquire the iron-founding business carried on at Burton-on-Trent, Staffordshire, as Thornewill & Warham.

HENRY E. HOOLE & COMPANY, LIMITED. Capital £10,000, to acquire the iron-founding business carried on at Green Lane Works, Sheffield, as Henry E. Hoole & Company.

HERBERT FROOD COMPANY, LIMITED.—Capital £8,812, to acquire the engineering business carried on at Sovereign Mills, Chapel-en-le-Frith, Derby, as the Herbert Frood Company.

GEORGE NUTTER & SON, LIMITED.—Capital £3,000, to acquire the iron-founding business carried on at Burnley as George Nutter & Son. Registered office: Elm Street, Burnley.

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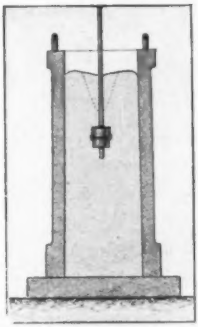
THE fourth annual convention of the British Foundrymen's Association will be held in the Department of Applied Science of the University of Sheffield, St. George's Square, on Tuesday and Wednesday, August 6 and 7, under the presidency of Mr. H. Pilkington. On the first day of the proceedings the President will deliver his address, which will be followed by an address by Professor Arnold (Sheffield University), and the following papers:—"Practice and Theory," by Mr. Percy Longmuir; "The Foundryman: Past, Present and Future," by Mr. W. H. Sherburn. In the afternoon a visit will be paid to the works of the Sheepbridge Coal and Iron Company, Limited. On the following day, Mr. T. Swinden will make a practical demonstration of pyrometery, and a paper, entitled "The Changes in Cast Iron during and after Solidification," will be read by Mr. E. L. Rhead, Lecturer on Metallurgy, Manchester School of Technology. Mr. E. Houghton will also contribute a paper on "Special Alloys for Foundry Use." In the afternoon there will be a visit to the steel foundry of S. Osborne & Company, Limited, and Cammell Laird & Company, Limited, and in the evening a smoking concert at the King's Head Hotel, arranged by Mr. W. F. Bagnall, Sheffield. On Thursday, August 8, a drive has been arranged to Chatsworth, Haddon Hall, and Bakewell.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

Reducing Piping in Steel Ingots.

STEEL BLOCK SHOWING PIPING



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APPEARANCE OF BLOCK AFTER TREATMENT.

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ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1905-7.	1905-6.
Iron—Scotch pig warrants ... ton	*65/0	56/6
—Middlesbro' warrants ... ... ton	56/10½	51/3½
—W.C. M/nos Bessemer ... ... ton	82/0	65/6
—Stock, Scotch, July 30 ... tons	2,097	11,660
Copper—Chili bars, GMB ... ... ton	£86 15/0	£82 0/0
—Stock, Europe & afloat... ... tons	—	7,400
Tin—English ingots ton	£186 10/0	£173 0/0
—Straits ... ton	£182 10/0	£171 2/6
—Stock, Ldn. Hlnd and afft ... tons	13,183	13,013
Lead—English pig ton	£20 10/0	£16 18/9
Spelter—Ord. Silesian ... ... ton	£23 5/0	£26 7/6
Quicksilver-(75lb.) bottle	£6 16/0-£7	£7 5/0
Antimony—Regulus ... ... ton	£43-£45	£109 0/0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	7 0 0	to	7 5 0
Pipes, 1½ to 2½ in.	5 10 0	to	5 15 0
,, 3 to 4 in....	5 2 6	to	5 10 0
,, 5 to 8 in.	5 0 0	to	5 2 6
,, 10 to 16 in....	5 0 0	to	5 2 6
,, 18 to 24 in....	5 0 0	to	5 2 6
Chairs	4 2 6	to	4 5 0
Floor plates (open sand)	3 10 0	to	3 15 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 17s. 6d.; light wrought, £1 12s. 6d.; heavy cast, £2 11s. 6d.; all per ton f.o.b., London. Copper (clean), £81; brass (clean), £47 0s.; lead (usual draft), £17 10s.; tea lead, —; zinc, £17 0s.; all per ton delivered merchant's yard.

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GROUND GANISTER,

Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

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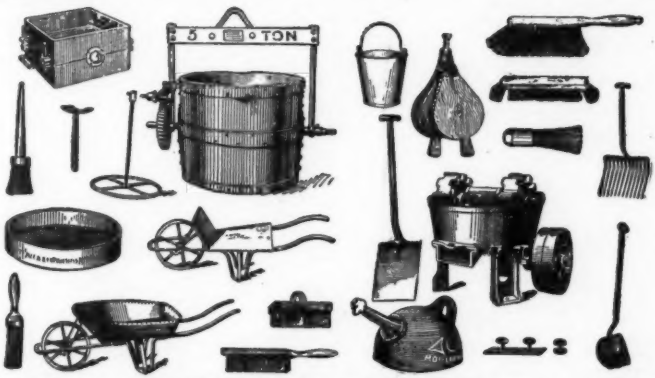

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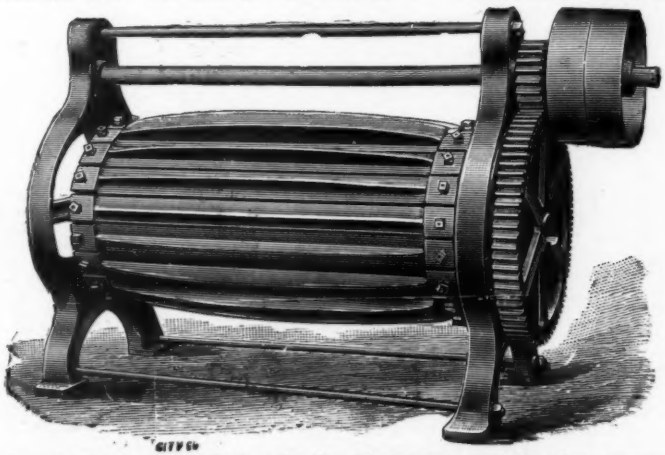

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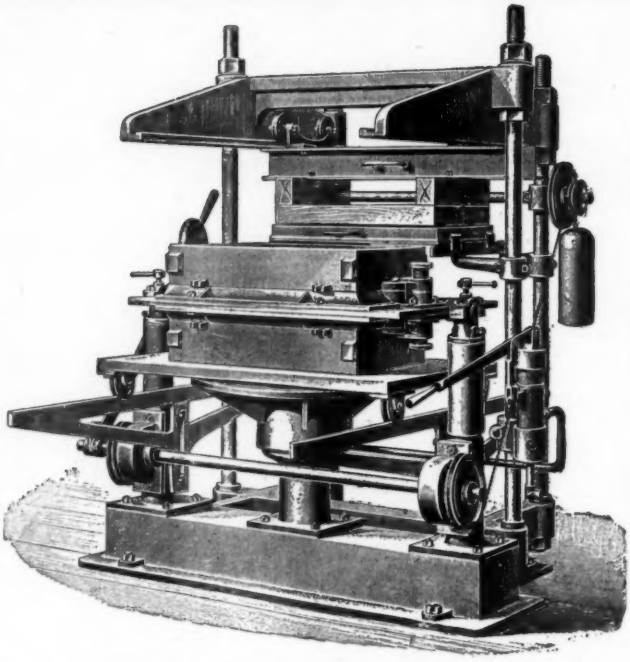

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Pattern "L."

This machine is fitted with a revolving pattern plate carrying one half of the Pattern on each side. It is constructed in all sizes from 19 in. by 10 in. to 87 in. by 87 in., and can be arranged with a draw up to 20 in. Bottom and top boxes are made alternately. With small machines the extraction of the pattern is done by a lever, with the larger sizes by hydraulic power. Any shape or size of box can be used on the machine within the maximum capacity, and in the majority of cases existing pattern plate can be utilised. The pattern is drawn upwards out of the sand without enlarging or breaking the mould. The machine is unsurpassed for deep work and we shall be pleased to show it to you in operation here.

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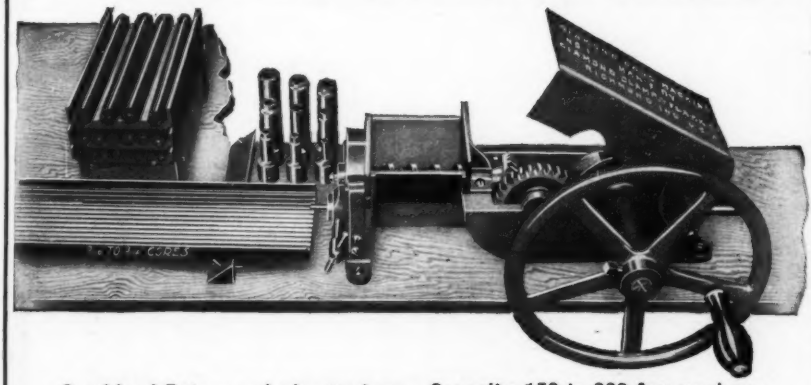

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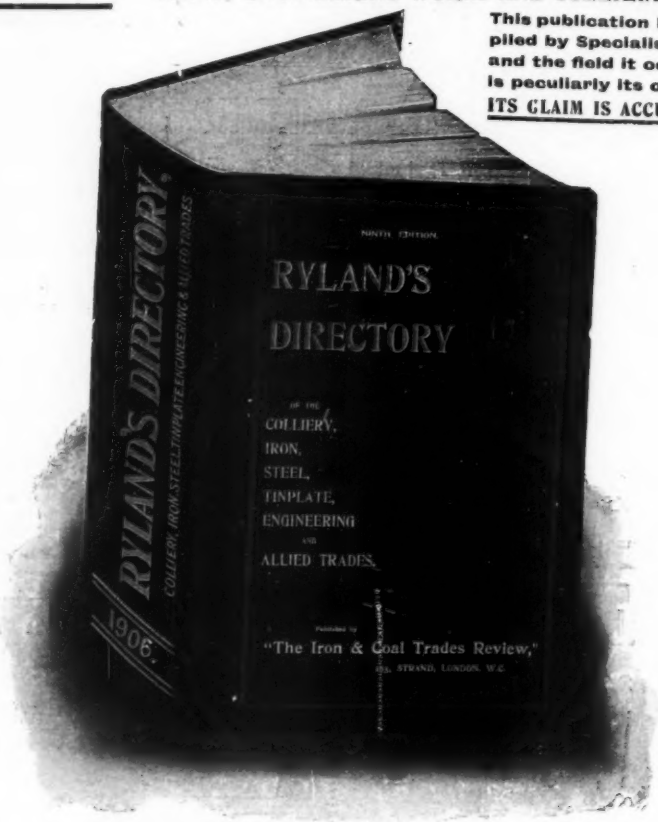

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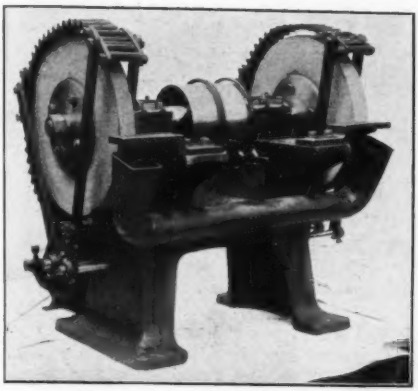

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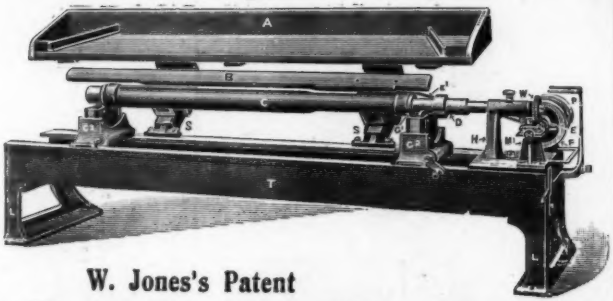

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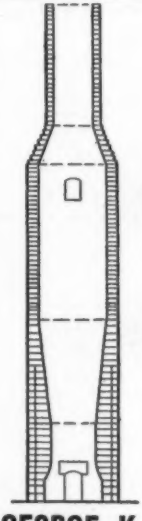

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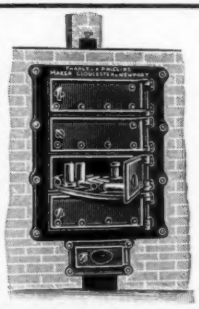

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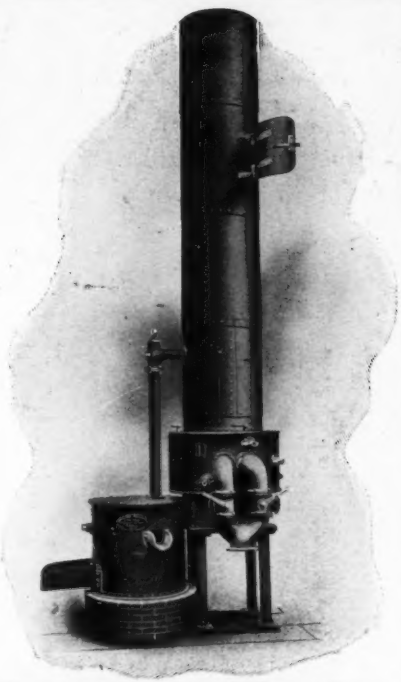

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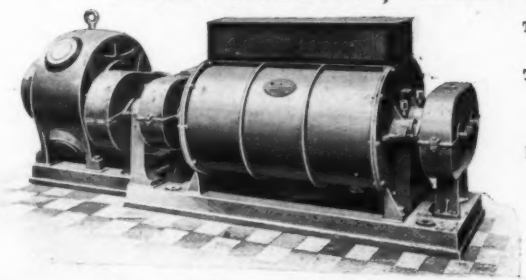

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